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Adoption of "Standard Size" for Engineering and Contracting

Nearly all technical and engineering periodicals use the "standard page" whose size is 9x12 in. During the past year we have received many requests from readers and advertisers to adopt this standard size. Accordingly, it was decided some months ago to change to the "standard," beginning with the first issue in July, and our advertisers were notified to that effect. To our readers the present issue comes as the first announcement of the change. We believe that the shorter page will be welcomed by them because of the decreased height of shelf needed for the bound volume.

A Year of Rotated Special Monthly Issues of This Periodical

A year ago this journal began publishing four special monthly issues which were rotated so as to provide a weekly magazine covering the entire civil engineering and contracting field, and at the same time giving four monthly magazines and one quarterly. The plan has not only met the hearty approval of nearly all our old subscribers, but it has enabled us to secure new subscribers at a much faster rate than hitherto. In fact we have averaged more than 30 new subscribers per 1,000 sample copies throughout the year.

It has been decided to change the name and the scope of the quarterly issue which is published on the fifth Wednesday of three months of the year. The new name will be Price and Market Quarterly. In that issue will be given prices of materials, rates of wages, bidding prices, etc., for all parts of America during the preceding three months. In addition there will be statistical charts showing price and wage curves for each of the preceding 12 months or longer, from which the general trend of prices can be seen. We believe that both engineers and contractors will find these trend curves of great utility in estimating the probable cost of future work.

One of the common errors in cost estimating arises from the use of existing prices without any consideration of the trend of prices. As long as the war lasts, and probably for 6 or 8 years afterward, there will be marked upward movements in prices and wages, just as there were during the civil war and for a decade following it. It is our opinion that although wages have been steadily rising for three years, we shall witness a continuation of this rise for years to come. If this is likely to happen, nothing will disclose the probability more clearly than curves of wage rates. And if it becomes apparent from study of such curves that wages are headed upward, month after month, we look to see civil engineers advising no let up in construction programs on the ground that prices are higher now than before the war.

It is our plan to make the Price and Market Quarterly issue of Engineering and Contracting indispensable to all who estimate construction costs, and this means to the great majority of our present subscribers whether they are engineers or contractors.

The Labor Cost of Laying a Monolithic Brick Road

In Vermilion County, Illinois, about 25 miles of monolithic brick roads have been built. The brick paving (4 in. thick) is 10 ft. wide laid directly on green concrete 5 in. thick at the center and 4 in. at the sides.

A gang of 32 men and a foreman on one contract job was capable of laying over 800 sq. yd.—sometimes nearly 900 sq. yd.—of concrete base and brick wearing coat, as a good day's output. About half the gang laid concrete and the other half laid brick. This gang did not deliver the materials from the freight cars to the road. Materials were delivered on a narrow gage (2 ft.) track laid alongside the pavement. The sand and stone were dumped from cars on the subgrade, and the brick was stacked in piles on the other side of the car track.

Assuming an average wage of $2.50 a day for the concrete gang of 15 men, the labor cost of mixing and placing concrete was less than 5 ct. per sq. yd. when the work was moving smoothly.

The brick laying gang was organized as follows, and the wages are assumed as given:

3 bricklayers at $4	$12.00
3 stacking brick from cars at $2.50	7.50
5 carrying brick from stacks to road	12.50
1 culling brick	2.50
1 rolling	2.50
3 grouting	7.50
1 wetting brick and moving forms	2.50
Total, 800 sq. yd. at 6 ct.	$47.00

In stacking brick and in delivering brick onto the road, the bricks were handled with tongs. Note that it required 5 men to deliver, with tongs, enough bricks to lay 800 sq. yd. per day, which is equivalent to only 160 sq. yd. per man. Contrast this with the number of brick delivered per man-day by the use of a gravity roller conveyor, as given in Gillette's "Handbook of Cost Data," p. 353. It is there stated that 4 men delivered enough brick to 3 pavers to lay 1,500 sq. yd. in a day, or 375 sq. yd. for each of the 4 men, using three gravity roller conveyors for the purpose. This, it is true, is very rapid work. However, it is self-evident that men can not possibly compete with a gravity roller in transporting brick from stock piles to a pavement.

Why Motor Truck Drivers Should Be Paid a Bonus

A motor truck is always more economic than teams and wagons wherever the truck is kept moving nearly all of a working shift and with a small repair cost. The daily mileage and the repair cost are largely in the hands of the truck driver.

A daily record should be kept of the number of trips and the mileage covered by each truck, also of the time lost for repairs and for other reasons. Based on the mileage performance each month, the driver should receive a substantial bonus for all mileage in excess of a specified amount. But if his bonus payment is limited to mileage performance, he is apt to race the truck. When this is done, and particularly where the road is rough, the repair costs may rise to such an extent as to offset any gain secured through rapid travel. Therefore a second bonus should be offered to the driver, based on the number of dollars in repairs that he saves each month from a stipulated monthly repair allowance.

Where this was done, using 2-ton trucks for hauling broken stone over an old gravel road, the costs per ton-mile were kept below 6 ct. inclusive of interest and depreciation. This was half the cost of similar hauling with teams at $5 a day, hauling two tons to a load and traveling 20 miles daily.

"Success Is Won by Enthusiasm and the Habit of Constant Thought"

A few months ago Prof. Elihu Thomson, past president of the American Institute of Electrical Engineers and inventor of 700 patented devices, was presented with the John Fritz Medal "for achievements in electrical inventions, in electrical engineering and in industrial development in scientific research."

The leading address made at the time of the presentation of the medal was by E. W. Rice, Jr., president of the General Electric Co., of which we quote part from the Electrical World:

> One of the most extraordinary things about his experimental work is its low cost. I am sure that if a prize were to be given for the inventor or engineer who could make a dollar go farthest and produce the greatest results Professor Thomson would have no worthy competitor in this or any other country, and I say this because I have had some experience with other inventors! He seems to possess an almost intuitive insight into nature and her ways, probably because of the quickness and accuracy of his perceptions combined with the most remarkable depth and range of his scientific knowledge, all helped by a marvelously retentive memory. In fact Professor Thomson, perhaps more than any other inventor since the days of Henry and Faraday, combines in his person profound and accurate scientific knowledge with extraordinary technical skill.

Mr. Rice has been intimately associated with Prof. Thomson for 36 years.

In a brief response to the tribute that he had received, Prof. Thomson said that to young men the road to scientific renown seems long and blocked by many obstacles, but that success may be won by enthusiasm, the habit of constant thought and the determination to regard difficulties only as stepping stones to victory.

Enthusiasm, constant study and determination are "the three graces" that characterize the scientific victor, according to Prof. Thomson. A few weeks ago we quoted Henry Ford's "Read a lot, think a lot, work a lot," as being the practice of the successful business man. In widely different fields and of equally wide differences in training and temperament, Thomson and Ford urge constant study as an essential to success. How many graduates of engineering colleges now entering their professional life are doing so with the determination to read and think a lot? Are they not, for the most part, inclined to regard their graduation as an escape from study? Is there not a prevalent feeling among engineers that personal experience can be made to serve in place of reading and thinking? If so, would it not be wise for every engineer to go frequently to a large engineering library and there measure his personally gained knowledge against the published knowledge of the whole engineering profession? By such a measure, how little every one of us becomes, our personal achievements dwindling to a picayune in the great gold reserve of the world.

Oregon's Vote of $6,000,000 for State Roads and Its Significance

On June 5 the citizens of Oregon voted $6,000,000 for state roads. It is noteworthy that at the very time that some so-called leaders of public thought are advocating curtailment of road building programs on account of war, the votes cast by the citizens of an entire state are overwhelmingly in favor of road building on a larger scale than ever. Note also that this is the first vote of its kind since the entrance of America into the world war.

Spurred to greater activity by the recent federal appropriation of $75,000,000, many states that had hitherto spent little or nothing from the state treasuries for roads, have entered upon a comprehensive road building program. It would be most deplorable if penny wise and pound foolish propagandists of "war time economy" were able to scare the public into abandoning any part of the recently developed plans for road improvement.

Illinois to Vote on a $60,000,000 Road Appropriation

Although it will not be till a year from this fall that the citizens of Illinois will vote on the $60,000,000 bond issue for state roads, every civil engineer and contractor in Illinois should begin to win converts to this great highway plan. In a nutshell, the plan is to build about 1,100 miles of hard roads annually for four years, and "pull the state of Illinois out of the mud."

It may be objected that war taxes make it inexpedient to enter upon so large a program of road building. This objection must be met with the irrefutable fact that the cost of hauling farm products will be lowered to such a marked degree wherever hard roads are built that there should be no postponement of this road building program on the score of economy.

Although motor trucks can be used on dirt roads, their efficiency is much less than on hard roads. In rainy weather the dirt roads of Illinois become practically impassable for loaded vehicles of any kind, and the heavier the load the more certain it is that it can not be hauled to market through the mud that makes Illinois famous.

The proposed Illinois road system has been scientifically laid out by the State Highway Department, connecting the 102 county seats with one another and with the important cities of the state. Motor vehicle licenses are to be doubled, through a bill just signed, and these licenses will alone pay the interest on the $60,000,000 of bonds. The principal will be retired through taxes spread over a period of 20 years, making only $3,000,000 a year to be raised by this great and prosperous state.

"The Honor System in Contracting"

At the last annual convention of the Texas Association of Civil Engineers Mr. F. A. Jones read a paper having the title above given. The "honor system" that he advocates is the cost plus a fee system, which his experience leads him to prefer to a lump-sum or unit-price form of contract.

Without doubt Mr. Jones is one of many engineers who have gradually been won over to advocacy of some form of "cost plus" contract. In the road field it has long been a matter of serious concern to highway engineers that so many contractors fail to complete their work at a profit; for when a contractor is losing money there is not only a strong incentive to slight the work but to use the least deviation from specifications or design as a basis for a claim for "extras" that are exorbitant. Each season brings a new crop of road contractors into the field, and they are usually men of little or no experience, in consequence of which they bid too low on work and become the season's "successful bidders."

This condition certainly calls for some sort of remedy. Shall it be secured through the rejection of the bids of inexperienced men? Or shall the cost plus a fee contract be adopted? Or shall road work be done by day labor instead of by any form of contract? These are the three questions that recur with increasing frequency.

One Cause of High Prices for Roadwork and a Remedy

Recently 18 bids were received for county road work at prices not much above those of last year, while no bids at all were received for a road by the state highway department in the same state. Inquiry reveals what appears to be the main reason for this difference between county and state road contractors. The roads were of the same class, but the state prescribed a time limit with a penalty clause, whereas the county provided that the time limit would be extended if sufficient labor could not be secured at reasonable rates or if delays were experienced in securing materials.

This instance proves quite conclusively, we think, that a considerable part of the high prices bid by road and street contractors is of the nature of insurance against the unusual risks begotten by war conditions. Hence if the risk is assumed, at least in part, by the public, contract prices will fall.

City, county and state engineers will do well to confer with contractors before writing the terms of contracts, particularly as to time limits. If this is done, we doubt not that many an old form of contract will be revised, for the common sense of engineers is certainly not less than that of business men who are daily entering into contracts for goods provisional upon ability to secure cars and materials.

The New Year Book of the American Highway Association

The sixth annual edition of the Good Roads Year Book is now available to road builders (address American Highway Association, Colorado Bldg., Washington, D. C.).

In the 556 pages of this volume there is a great deal of useful information, grouped under three general heads: Part I gives information regarding road improvements under federal, state, territorial and local control. In the 218 pages of this section of the book are to be found brief summaries of state-aid road laws, convict labor laws, progress reports as to road mileage, automobile licenses and other monies annually available for roads, the names of highway officials, etc.

Part II contains almost 200 pages on the construction and maintenance of rural roads of every type. This section has been contributed by eminent highway engineers, and forms an admirable, succinct resume of the latest and best road practice.

Part III is mainly statistical, and in its 100 pages includes the names and addresses of 3,000 contractors who bid on road work in 1916. It gives a bibliography of about 250 books, reports and pamphlets relating to highway work. To every highway engineer and student of highway construction and maintenance this bibliography will be invaluable. The bibliography includes neither articles in periodicals nor publications of state or federal highway departments. While it has been wise to exclude articles, because their number is legion, we think it would be greatly appreciated by engineers if titles of federal and state road bulletins were included.

This is a book that should be in the hands of every road builder.

Experimental Data on Wheel Loads Needed

What area is in contact with a road surface for a wheel with a steel, solid rubber or pneumatic tire? How is the pressure distributed over the area in contact? What are the comparative elasticities of wheels and pavements? What is the effect of impact on pavements? These questions are fundamental to a successful study of foundations and the traffic limits of various pavements.

There appears to be but little experimental data on this important subject. Road authorities and engineers have devoted much time to the discussion of various pavements and weighty opinions are given. Upon analysis such opinions are in general based on personal experience only, and while of great value to the one are of but little use to those unfamiliar with the local conditions upon which the opinions are based.

We suggest more experimental data on wheel loads and less "confession of ignorance" by resorting to the age-old "matter of judgment" excuse.

Logic for Engineers—Induction and Deduction

By HALBERT P. GILLETTE

[The previous articles of this series are: I—Energy and Cause-Effect, Jan. 31; II—The Senses and Feelings, Feb. 28; III—The Categories of Energy (Number), Mar. 28; IV—The Categories of Energy (Space and Time), April 11; V—The Categories of Energy (Mass), May 9; VI—An Explanation of Mental Processes, May 30.]

Inference. Logicians commonly give three classes of reasoning or inference: (1) Reasoning from a particular case to a particular case; (2) Reasoning from several particulars to a universal conclusion; and (3) Reasoning from a universal to a particular conclusion.

The first of these is called analogical inference; the second, inductive inference; and the third, deductive or syllogistic inference.

Illustrative of analogical inference is the conclusion that because the bite of one snake, A, has been poisonous, the bite of another snake, B, will be poisonous.

Illustrative of inductive inference is the conclusion that because the known bites of all rattlesnakes have been poisonous, the bites of all rattlesnakes, past, present and future, are poisonous.

Illustrative of deductive inference is the conclusion that because the bites of all rattlesnakes are poisonous, the bite of a particular rattlesnake, A, will be poisonous.

Prof. Thomas Case says:

> "Inference is that mental operation which proceeds by combining two premises so as to cause a consequent conclusion. . . . It requires the combination of at least two premises to infer a conclusion different from both. . . . Though the premises contain the conclusion, neither premise alone contains it." (Logic, Encyclopedia Britannica.)

If my explanation of automatic induction and deduction, given in my last article, is correct, and if volitional thinking has evolved from automatic thinking, then it is not true that inference is a combination of two premises to produce a conclusion differing from both of them.

A premise is a judgment, or a proposition that expresses belief. We certainly do not combine two judgments when we observe a thing, nor do we do so when we remember a thing. Yet we reason or infer when from an observation of one characteristic of a thing we are led to remember another characteristic of the thing.

When a man observes a deer's track he remembers that the peculiar shape and size of this mark in the earth is the sort of mark that he has seen a deer make; and this memory alone constitutes his inference that some deer made the track that he now sees. We saw in the last article that a deer infers the presence of a lion by smelling its peculiar odor, and that the deer also infers consequent risk of death to itself. Yet the automatic deductive inference of the deer involves no process other than observation of a given thing and memory of other things associated therewith.

We may employ the artifice, if we wish, of calling a complex sense-record one judgment or premise; the activating of part of that sense-record we may call another judgment or premise; and the replaying of the rest of the complex sense-record we may call a third judgment or inferred conclusion. But we should not let such an artificial demarkation and numbering of parts confuse our understanding of the entire process of deductive reasoning, as I believe it has been confused by logicians from Aristotle to date.

Thus Mill says:

> Induction is a process of inference; it proceeds from the known to the unknown. . . . It is inferring something unobserved from something observed.

Thus, the generalization that "all crows are black" is a passing from the "known" fact all crows thus far seen by man have been black to a generalization that asserts that even the as yet unseen and unknown crows will all be black. Until we come to the articles on Classes and Class Marks, and on Mathematical Deduction, we must defer discussion of this seeming mystery of a passing from the known to the unknown by a process of reasoning. But it may be said now that there is, literally speaking, no such thing as "proceeding from the known to the unknown" by a purely mental process of combining two judgments or premises. The false doctrine that such a thing is possible accounts for countless fruitless attempts to arrive at increased knowledge merely by "logically combining" pre-existing facts. Sir Francis Bacon was among the first to protest against such attempts, but he failed entirely to perceive the fruitfulness of reasoning by analogy or hypothetical deduction as a means of guiding the mind to the perception of new facts.

The Will. Although man has invented mechanical devices, notably the camera and the phonograph, that resemble the receiving action of two sense organs, nothing exists, either among human contrivances or in inanimate nature, that seems to bear resemblance to the Will. By Will is here meant the mental power that directs attention to a given thing and determines upon an action. Since we know of nothing resembling this mental power, it transcends explanation in the present state of our knowledge, and may ever continue such transcendence. Coming to this non-explained mental energy—spirit, ego, what-not—let us call it Will. To define it in terms of other energies is at present impracticable. But we can state what the Will does, although we remain ignorant of what the Will is.

The Will has the power to move the "switches" of the brain. The Will may be said to focus attention upon a given sense-record, and thus cause the given record to become active. Sense-records become active ether in this way—i. e., by the action of the Will—or, automatically. If the Will firmly directs attention upon a given muscular sense-record, thus making the sense-record active, the muscles will reproduce the action recorded on the sense-record.

That the Will is itself a physical or chemical energy is evident, for long concentration of attention produces weariness. There is a consciousness of effort in willing or attending to a sense-record.

The Will is limited in its capacity to attend to many sense-records. Close attention to one sense-record involves at least partial and often total oblivion to other sense-records.

Volitional Induction. Automatic induction gradually evolved what is commonly called induction, or what may be called volitional induction. For when the Will acquired the power to focus attention upon any desired sense-record there evolved a means of classifying similar sense-records. Thus it became possible voluntarily to group together those sense-records that possess similarities. To illustrate: A savage seeking food observes that an animal leaves a footprint in the soft earth near a drinking pool. He remembers that he has seen similar tracks before at this pool, and, as he reflects, he recalls pool after pool surrounded by tracks. He, therefore, forms a mental picture of tracks as invariably surrounding a drinking pool. Expressed verbally this mental picture would be stated thus: All drinking pools are surrounded by animal tracks.

This volitional generalization differs only in one respect from an automatic generalization, namely that it was arrived at by reflecting or voluntarily reproducing many old sense-records of different drinking pools, and noting their uniform quality of having tracks in the moist earth around the pools. Precisely the same generalization about drinking pools might be formed automatically by an animal not capable of voluntarily recalling old sense-records. The animal would see pool after pool, and if there always were tracks also seen its composite mental picture of drinking pools would include tracks. So the animal's automatic generalization would also be equivalent to: All drinking pools are surrounded by animal tracks.

Let a savage witness, for the first time, an attack of a lion upon a herd of deer at the drinking pool. Now, suppose the savage conveys to other savages an account of the attack he has witnessed, and is told, in turn, by each of them that they have witnessed similar rushes of a large, roaring, tawny beast upon deer at drinking pools. The savage would then generalize thus: Every large, roaring, tawny animal attacks deer.

The savage has arrived at precisely the same induced generalization as the deer has arrived at, and in a manner quite similar. The deer has automatically generalized through the progressive scribing of similar sense-records on its brain, and has inherited similar records. The man has voluntarily generalized through the comparison of his own sense-records with similar sense-records transmitted to him in words and signs by his associates. The ultimate distinction, then, is found to lie solely in the difference between automatic and voluntary reproduction of sense-records.

This conclusion is of the greatest import. We are now in position to see the fallacies that exist in all published explanations of the process of reasoning from particular instances to general conclusions, or induction. From Aristotle's day to this, induction is described as the process of "combining two judgments to produce a third." As a **matter of fact, induction—whether automatic or voluntary—is a process of building up a sense-record that will always synchronize with certain energy-groups.**

The sense-record that I have formed of the sort of animal called "lion" is an induction. The word "lion" is not itself an induction, but my sense-record of a "lion" is an induction, and I must state at least part of the induction the moment I define the word "lion." Defining, as we shall see later, consists in naming a few of the prominent characteristics of a thing; but to state a characteristic is itself to state a generalization—an induction—about a thing.

In automatic induction there is evidently not a "combining of two judgments to produce a third," but a repeated scribing of similar picture upon similar picture, until a general picture of related things is formed. Voluntary induction is exactly the same sort of process, but it is greatly aided by the will. Instead of waiting for similar phenomena to happen, the will can direct attention to similar instances that have happened, can conduct a search for other instances, and can cause instances to happen.

If we choose we may artificially segregate sense-records into several classes. For example, into (1) inherited sense-records or instinctive knowledge, and (2) personal sense-records or acquired knowledge. But let it not be overlooked that so-called acquired knowledge is a complex of facts the basic elements of which are all inherited. As an other example, we may artificially classify sense-records into (1) those acquired by immediate perception, and (2) those acquired by a perception arising from long and careful study. Thus a sense-record of a lion formed upon first seeing and hearing a lion yields knowledge of the salient characteristics of lions, such as the size, shape, color and voice. Every subsequent perception of a lion intensifies these marks, until such a generalization as this may be formulated: Every lion is tawny and roars. If we choose, we may call a generalization thus derived by repeated direct observation by some other name than an induction; and we may reserve the word induction either for some more complex process of observation or for one involving search for less readily perceived characteristics. But let it be noted that between the easy and the difficult, the simple and the complex, the brief and the long, there is no precise line of demarkation.

Volitional Deduction. As we have seen, automatic deduction may be separated into two steps. First, the making of an old sense-record active, due to synchronism with a similar thing newly sensed; and, second, the automatic reproduction of subsequent parts of the old sense-record, as when the odor or roar of a lion makes the deer infer the lion's attack. Volitional deduction follows precisely the same order as automatic deduction, and the process is the same, excepting only that the will directs attention to the parts of the sense-record.

Thus, the savage, hearing the roar of a lion, deduces the presence of the beast. His deduction, expressed in words, takes this form:

(1) Every lion roars so and so, is tawny, large, ferocious, etc.

(2) This thing roars so and so.

(3) Therefore, this thing is tawny, large and ferocious, etc., and is a lion.

In other words, by sensing one or more of the characteristics of a lion, the savage infers the rest of its characteristics. That is, the savage deduces that this particular roaring thing is a lion.

If a man hears a caw, although he may not see the crow that makes it, he infers the presense of a crow. Formally stated, his reasoning takes this form.

(1) All crows caw and are black.

(2) This thing caws.

(3) Therefore, this thing is a crow and is black.

In general, then, the process of deduction consists in deciding that a thing belongs to a given class because it has certain characteristics of the given class; or, in other words, it is inferred that it has all the other class characteristics because it has some of them.

Let us now contrast this theory of deduction with the old theory that still prevails—the syllogistic theory fathered by Aristotle. A **syllogism** consists of a (1) major premise, a (2) minor premise, and a (3) conclusion formed by combining the subject of the minor with the predicate of the major, thus:

(1) All crows are black.

(2) This thing is a crow.

(3) Therefore, this thing is black.

The "combination of two judgments produces a third judgment" or conclusion, according to this syllogistic theory. The Aristotle syllogism has impressed some men as being childish, and it has been criticised by many reasoners on the ground that it "begs the question." But it seems to me that its great underlying defect has never been pointed out. Contrast the syllogism just given with the example of the actual order of deductive reasoning previously cited, namely:

(1) All crows caw and are black.

(2) This thing caws.

(3) Therefore, this thing is a crow and is black.

We do not here have two mental-pictures combining to produce a third mental-picture. What we do have is one mental-picture recognized as being part of a larger mental-picture. The caw coming from a tree is the mental-picture (2) that is part of a larger mental-picture (1), namely, that of a crow and its environment. This is quite a different process than that illustrated in the Aristotelean syllogism.

If the Aristotelean syllogism really obscures the actual process of deduction, as I believe it does, then we should expect to find controversies among logicians about the nature of deduction, and we do. We should also expect to find confusion as to the difference between induction and deduction, and we do. Mill contends in one place that all inference is inductive and that the syllogism is only a process of "interpretation," yet in another place he contradicts himself by contending that all induction is really syllogistic. In this last opinion he merely agrees with Aristotle, who regarded all induction as a special form of syllogism.

As the inevitable consequence of belief in the Aristotelean syllogism there evolved what is known as a system of "formal logic," in which verbal propositions are treated as if they were equations, by the combination of two of which a third is derived. Thus:

(1) a is b.

(2) c is a.

∴(3) c is b.

Qualitative deduction would indeed be a simple process if it consisted merely in combining two verbal propositions to form a third. Then such reasoning would be quite as mechanical as the process of combining two equations. But, unfortunately for those who would thus travel a royal road to knowledge, deductive reasoning does not take any such form as the syllogism of Aristotle implies or the mathematical syllogism of the "formal logicians" asserts.

In a later article on Quantitative Deduction I will show that mathematical or quantitative deduction is not merely deductive inference but a mechanical process, and that it consequently differs radically from qualitative deduction.

Induction is a process of grouping similar things into a class having known characteristics or class "marks." Deduction (qualitative) is a process of identifying a thing as belonging to a class by virtue of its possessing enough of the class marks to insure its possession of the remaining class marks. Deduction is quite distinct from induction, yet supplementary to it.

The state of Maryland has limited the weight per inch of tire for truck traffic to 650 lb. On a few of the roads specifically named the limit is placed at 750 and on the others at 800 lb.

Cost Data on Operation of Small Maintenance Trucks

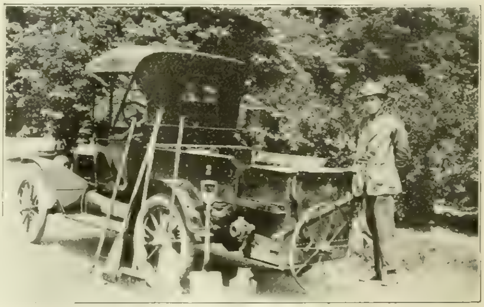
By FRANK T. SHEETS,

Asssistant Maintenance Engineer Illinois State Highway Department.

The Illinois State Highway Department now has in operation five small maintenance trucks which are used in keeping up the widely scattered mileage of state aid roads in Illinois. The principal work consists of filling cracks in concrete roads.

Ford with Smith Form-a-Truck Attachment Maintenance Truck Used by Illinois State Highway Department.

Truck No. 1 is an ordinary Ford runabout fitted with a box for hauling material. This truck pulls a trailer which carries a heating kettle and miscellaneous tools. Trucks No. 3 and No. 5 are also Ford runabouts to which small boxes and heating kettles have been attached. Trucks No. 2 and No. 4 are Ford cars fitted with Smith Form-a-Truck attachments. All of these cars have proved very efficient in performing the class of work required of them.



Ford Maintenance Truck Used by Illinois State Highway Department.

REPORT OF TRUCK OPERATION FROM START OF SEASON OF 1917 TO MAY 26.

Truck No.	Type of truck.	Mileage previous to this season.	Mileage this season.	Gasoline used— Gallons.	Gasoline used— Cost.	Miles per gallon.	Gasoline cost. Cts. per mile.	Total cost of operation.	Total cost of operation. Cts. per mile.
1.	Ford with trailer	13,265	1,926	118	$28.75	16.3	1.49	$76.71	3.98
2.	Smith Form-a-Truck:								
	Engine	6,000	1,821	139.5	31.73	13.1	1.74	67.09	3.68
	Truck attachment	0							
3.	Ford	4,015	1,376	143	28.61	9.63	2.08	62.03	4.52
4.	Smith Form-a-Truck	0	1,293	141	27.85	9.18	2.16	45.06	3.49
5.	Ford	0	2,300	151	30.52	15.2	1.33	55.27	2.40

The accompanying table gives the mileage and the cost of operating these machines from the beginning of this spring to May 26. The heading "Total Cost of Operation" includes all incidental repairs, but does not include salary of operator, interest on the investment, depreciation or the first cost of tires. Experience indicates that the cost of tires will average about $5 per tire per 1,000 miles run.

The maintenance of state aid roads is under the general supervision of W. W. Marr, Chief State Highway Engineer.

Haulage Methods and Cost Data on National Road Improvement in Ohio

Work has been underway for the past two or three years on the reconstruction of the National Road through Ohio. At the end of 1916, 93 miles had been completed or was in process of construction. In carrying out this work the haulage of materials was a difficult problem for the contractors. All four of the chief means were employed. About one-third of the materials required to construct this 93 miles of highway were delivered by teams, another third by industrial railway trains, and the remaining third should be about equally divided between motor trucks and traction engines. In a paper presented at the last annual meeting of the Ohio Engineering Society Mr. Robert N. Waid, Division Engineer of the State Highway Department, comments briefly on the hauling methods.

The traction engine train, according to Mr. Waid, was perhaps the least adjustable to the varying conditions. It appeared best adapted to fairly level, straight roads, which have not been paved, where the average haul was not less than ½ mile. The cost of hauling by this method, on the improvement under consideration, has been 24 ct. per ton mile.

Hauling by motor truck was quite successful. The large 7-ton trucks, which were first tried, did not work as well as the lighter 3-ton trucks, and several of the heavy trucks were exchanged for lighter ones. No motor trucks were used where the average haul was less than 2 miles. The cost per ton mile, where the trucks were successful, was about 14 ct.

In the 24-mile concrete section west of Zanesville and on the 7-mile brick section west of Cambridge, a 3-ft. gauge industrial railway was used to transport materials. The two chief troubles encountered consisted in operating over grades which exceeded 5 per cent and in maintaining the track after it had been down over winter. The actual cost of operation and maintenance was about 11 ct. per ton mile. The heavy investment for equipment, however, largely offset the low cost of operation.

The following cost data for the National Road improvement are given by Mr. Waid in his paper:

The average cost, to the several contractors, for grading was approximately 40 ct. per cubic yard. All classes of excavation for drainage structures cost on an average, $1.15 per cubic yard. Mixing and placing concrete in the small culverts cost $1.60 per yard. The cost of laying rubble masonry was $1.85 per cubic yard. The labor cost for building forms, for the concrete culverts, was $1.22 for each cubic yard of concrete. The cost of placing the reinforcing steel in the drainage structures was 55 ct. per 100 lb.

Recent road legislation in New Hampshire forbids any person or corporation from excavating or disturbing the surface of any state, trunk line or state aid road except in case of emergency without written approval of the state highway department.

Snow Fighting vs. Snow Removal at New York City

New methods of snow removal inaugurated in New York City by Mr. J. T. Fetherston, Commissioner of Street Cleaning, have more than threbled the rate of removal and also have reduced the cost 68 per cent. Under the new plan the old system of removal by contractors has been amended so that the city now does the larger part of the work by the direct employment of labor and the use of department equipment. The following outline of the methods employed is taken from the recently issued report of the Department of Street Cleaning, covering the year ending Dec. 31, 1916:

Owing to contracts in existence when the present administration assumed direction, application of the new principles was confined in the winter of 1913-1914 to a limited use of sewers for snow removal. As a result of the winter's experience and tests that were made, it became apparent that the city had had available for years a possible solution of the problem of rapid snow removal, through the extensive use of sewers, not alone after a snowfall, but during the progress of the storm. The experience of that winter demonstrated to the satisfaction of the administration that snow work should be started with the storm and clean snow dumped into the sewers as it falls. Such methods imply an attempt to keep pace with a storm, instead of trying to dig the city out after a block has occurred.

In the summer and fall of 1914 the Department made preparations to apply during the following season its new programme for handling snow. This preparation included a thorough survey of the city's sewer system, specialized instruction of the Department's forces, enlargement of standard equipment, enrollment of emergency workers as "snow fighters" and the plotting of the city so that practically 50 per cent of its entire area could be cared for by the simultaneous attacks of the "snow fighting" gangs, within four hours after the call to go to work. Plans called for pushing snow into sewer manholes by the use of panscrapers operated by hand, and drag-scrapers, each drawn by a single horse.

These plans did not eliminate contract snow removal, as large quantities of snow still had to be carted to the river dumps or main sewers; nor did they release the city railways from their obligations to clear the snow from certain streets carrying railway tracks. But up to this time the city had depended upon trucks alone to haul snow from the streets to water front dumps and, consequently, the speed of snow removal had depended upon the supply of trucks available for the work.

Results of the application of the new system during the winter of 1914-1915, as compared with preceding winters, showed that the rate of removal doubled as compared with the best previous record, and that the cost per cubic yard decreased 67 per cent compared with lowest previous unit cost record. The total fall of snow for the winter was 22.4 in., and the total cost of removal was $523,892. If the entire snowfall of the winter had been handled by contractors' trucking forces alone, at the lowest previous contract rate ($0.367 per cubic yard), the cost of the season's work would have amounted to $1,584,822. The total area of the streets in the three boroughs scheduled for snow work in the winter of 1914-1915 was 32,607,081 sq. yd., or 927 miles of streets.

When the first snow of the winter of 1915-16 arrived, it found the Department further strengthened by valuable additions to its equipment and better trained organization; but the beneficial effects of these improvements were counteracted, to some extent, by the shortage of labor available for emergency snow work. Schedules called for 14,737 emergency laborers, working in 9-hour shifts, while storms were in progress. The average number of men secured was 9,060, or 61 per cent of the required number. Use of snow plows, designed by the Department and attached to commercial motor-driven trucks, aided in reducing the effect of the shortage of labor. These plows were used for piling snow in the center or on the sides of streets.

Motor Snow Plows Used by Department of Street Cleaning.

Over 50 in. of snow fell during that winter, compared with the average fall of 32.2 in. The total area scheduled for snow work in the three boroughs had increased to 33,311,899 sq. yd., which represented 946.17 miles of streets. Nearly 12,000,000 cu. yd. of snow (truck capacity basis) were removed at a gross cost of $2,521,299.55, or at the rate of 21.2 ct. per cubic yard. This was more than double the quantity (truck capacity basis) removed by the city during any previous winter season, and the cost was less than half the average cost per cubic yard for the previous 7 years. No serious complaints were made regarding snow removal during the season, which is creditable to speedy action in opening main arteries with automobile snow plows, employment of the largest procurable force of emergency laborers during storms and the use of sewers for the disposal of snow.

Showing Method of Plowing Snow to Middle of Street.

Including the statistics of the snow storm of last December, the total fall of snow for the calendar year 1916 was 54.6 in.; average for the previous 47 years, 32.16 in. The daily rate of removal during 1916 was 198,000 cu. yd., compared with the grand average, 1907 to 1915, inclusive, of 71,886 cu. yd. Rate of daily removal during and following the storm of Dec. 15 last surpassed all previous records. There was a snowfall of 12 in. The cubic yards removed totaled 2,178,301. Nine days were required for completion of the task, the daily removal approximating 242,000 cu. yd. This record was achieved despite a shortage of labor, because of the almost perfect working of the system established by the Department. An important feature was the use of 120 city snow plows driven by commercial motor trucks.

The following tables present statistics of snow storms and snow removal work during 1916. The tables showing the area assigned to each of the three forces engaged upon snow work show only slight changes from the tables showing corresponding statistics in 1915.

TOTAL AREA AND MILEAGE OF STREETS.

Borough.	Street area, sq. yds.	Length, miles.
Manhattan	16,201,019	460.25
The Bronx	3,774,456	106.89
Brooklyn	13,250,053	376.68
Totals	33,225,528	943.82

SCHEDULE FOR SNOW FIGHTING FORCE.

Borough.	Street area, sq. yds.	Length, miles.
Manhattan	12,542,820	356.33
The Bronx	3,031,165	86.11
Brooklyn	8,885,701	252.43
Totals	24,459,686	694.87

CONTRACT SCHEDULE, MANDATORY STREETS.

Borough.	Street area, sq. yds.	Length, miles.
Manhattan	2,508,981	71.27
The Bronx	309,079	8.78
Brooklyn	2,930,400	83.25
Totals	5,748,460	163.30

STREET RAILWAY SCHEDULE.

Borough.	Street area, sq. yds.	Length, miles.
Manhattan	1,149,218	32.65
The Bronx	434,212	12.00
Brooklyn	1,433,952	41.00
Totals	3,017,382	85.65

DEPTH AND WEIGHT AND DENSITY OF SNOW.

1916.	Depth.	Density, per cent.	Weight per cu. yd.
February 2, 3	6.0	.16	269.46
February 13, 14	6.4	.15	253.80
March 2	3.2	.09	151.20
March 6, 7	7.6	.13	218.7
March 8	4.0	.14	234.9
March 10	1.4	.10	167.4
March 15, 16	4.1	.11	186.3
March 21	2.1	.04	67.5
March 22	2.9	.23	386.1
April 8, 9	2.3	.20	337.5
December 15	12.0	.05	84.4
	52.0		

SNOW FIGHTING VERSUS SNOW REMOVAL.

	Day's work.	Cubic yards removed.	Cost.	Av. cost per cu. yd.	Cu. yds. removed per day.
Contract snow removal	48	2,681,289	1,366,952	$0.509	55,860
City snow fighting	56	9,754,479	1,129,517	0.116	174,187
Total		12,435,768	2,496,469	$0.201	

SNOW EQUIPMENT ON DEC. 31, 1916.

Borough.	Auto plows.	Horse-drawn plows.	Sand spreading machines.	*Bags with auto plow parts.	†Boxes with auto plow parts.	*Boxes with tools.	Pan-scrapers.	Shovels.	Picks.
Manhattan	113	61	3	64	12	11	7,677	4,038	4,730
The Bronx	17	4	..	10	3	3	1,529	617	574
Brooklyn	39	18	1	26	5	5	4,058	2,869	2,132
Total	169	83	4	100	20	19	13,264	7,524	7,436

Borough.	Bleeding poles.	Red flags.	Flashlights.	Hydrant pumps.	Hydrant keys.	Nozzles.	Reducers.	Horse lengths.
Manhattan	484	11,984	104	210	925	306	171	660
The Bronx	90	2,860	14	43	139	43	30	105
Brooklyn	311	7,477	76	82	346	62	54	180
Total	885	22,321	194	335	1,410	411	255	945

*Carried on auto trucks for making minor repairs to auto plows in the field.

†Carried in stables for making repair to auto plows.

The average daily rate of removal for the two years under the old method was 51,390 cu. yd., at an average cost to the city of $0.535 per cubic yard. Under the new method, the average daily rate of removal for the two years was 234,211 cu. yd., at an average cost of $0.188.

New York Specifications for Emulsified Asphalt

During the season of 1916 the State Commission of Highways of New York used a specification for emulsified asphalt that gave very satisfactory results. Under this specification approximately 1,500,000 gals. of materials were purchased and during the present season about 800,000 gal. will be bought. It is probable that the specifications will be rewritten this season by the Commission, so as to include some other asphaltic materials, which will enlarge the field of supply and give a material that would in all probability give as good results as were supplied under the present specification.

The 1916 specification for the emulsion is as follows:

SPECIFICATION FOR BITUMINOUS MATERIAL COLD PATCH ASPHALTIC EMULSION.

The emulsion must be homogeneous.

It must mix with water in all proportions.

It shall be of such fluidity as to readily flow from bung hole of a barrel.

Any material accepted at time of shipment, which should prove to be defective by separation within 30 days after date of delivery, will not be paid for by the Department of Highways, and will remain the property of the contractor except when separation may be caused by freezing.

When distilled up to a temperature of 400° F., the total loss shall not exceed 32 per cent. Not over 2 per cent shall be an oil distillate. The residue from the foregoing distillation shall have the following characteristics:

(1) It shall have a specific gravity at 77° F. of not less than 1.01.

(2) The penetration shall be between 15 and 25 millimeters when tested for five seconds at 77° F. with a No 2 needle weighted with 100 grams.

(3) Its solubility at air temperature in chemically pure carbon disulphide shall be at least 98.5 per cent.

(4) The solubility of the bitumen at air temperature in 76° Beaume paraffine petroleum naphtha distilling between 140° and 190° F. shall be between 72 and 84 per cent.

(5) The bitumen shall show between 10 and 15 per cent fixed carbon.

(6) It shall not contain over 1.0 per cent of ash.

(7) It shall not contain more than 2.0 per cent paraffine scale.

(8) It shall have a ductility at 77° F. of not less than 40 centimeters (Dow mould).

(9) All cold patch asphaltic emulsion will be sampled by an engineer of the Department of Highways and samples sent to the Bureau of Tests, Albany, N. Y.

Mirrors 5 ft. wide by 3 ft. high are used on two dangerous curves on a section of road in the Municipal Mountain park in the city of Denver, Colo. The mirrors are carried on iron pipes cemented into the rock at the side of the road. Heavy copper covered wood frames are used to hold the glass and protect it from moisture. Each mirror cost $50 in place.

Removal of Excess Water in Concrete Road Construction

Tests of different methods of finishing a concrete surface in road work, conducted recently by Mr. A. N. Johnson in co-operation with Prof. D. A. Abrams of the Structural Materials Research Laboratory, Lewis Institute, Chicago, indicate that it is possible by proper manipulation of the concrete to secure increased strength and density of a character most desirable for a concrete road surface. The tests and their results were described by Mr. Johnson in a paper presented June 28, before the American Society of Testing Material, from which the matter following is taken.

In concrete road work, owing to the method of handling, it is of considerable convenience to use a fairly wet mixture. It has been found, however, that much of the excess water can be removed by proper manipulation of the concrete after it is placed. As a consequence some methods of finishing concrete roads have been productive of exceptionally good results. A study of the methods employed shows that while they differ as to detail, in each case the concrete surface has been so treated as to remove a considerable amount of the excess water, thereby making the surface more compact and dense.

Of the different methods which have been observed, that devised by Captain Gaillard, City Engineer of Macon, Ga., seems to be the most efficient and least expensive. This method consists in rolling the surface of the concrete with a light roller about 8 in. in diameter and 5 to 6 ft. in length, attached to the end of a long pole. The roller is made of light sheet metal; the total weight of a 6-ft. roller being in the neighborhood of 70 lb. The operator stands at one side of the roadway and rolls the newly laid concrete transversely to the direction of the road.

This method was originally developed to remove any unevenness in the surface, but it really accomplishes a very much more important result as it squeezes out of the concrete much of the excess water.

In order to determine the effect on the strength of a concrete produced by the finishing method described above, a number of slabs were made for testing purposes, mixed and molded in much the same manner as in concrete road work, the exact proportions of water and other materials being recorded. The principal variation was in the consistency of the concrete and the method of finishing the surface.

Twelve slabs, 2½ ft. wide, 5½ ft. long and 5 in. in thickness, were made and tested. Pebbles were used as coarse aggregate for six of these and crushed limestone was used for the others.

The concrete was mixed in the proportion of 1 part cement to 4 parts total mixed aggregate by volume—a proportion approximately equivalent to the ordinary 1:2:3 mix. Three sets of slabs, two slabs in each set, were made from both crushed limestone and pebbles as a coarse aggregate.

The following consistencies of concrete were used in the test:

1. Dry consistency, finished with a wood float in the ordinary way; 2. Wet consistency, finished with a wood float in the ordinary way; 3. Wet consistency, finished by means of a roller, as previously described.

The concrete for the slabs of dry consistency was mixed as stiff as could be easily handled—stiffer than is ordinarily found in concrete road work. The mixtures for the remaining slabs contained a somewhat larger amount of water, making a consistency that would ordinarily be classed as "good" in practical work. (See Table I.)

All slabs of the stiffer consistency, as well as one of the slabs of each other set, were finished by being first struck off with a straight edge and then floated by hand with a wooden float. The remaining slabs of each of the wet consistency sets were finished by the use of a roller. The concrete was left a little more than flush with the sides of the mold, and instead of being struck at once with a straight edge, it was first rolled; the straight edge was then used to strike off what surplus concrete remained. To bring the full weight of the roller—which was just long enough to rest upon the side forms—on the concrete the slab was rolled transversely at intervals of about 15 minutes for $1\frac{1}{2}$ hours, five rollings being made. The roller was moved back and forth over the width of the slab, moving sidewise a few inches with each stroke. As each rolling was made, considerable water was squeezed out of the concrete and forced over the sides of the mold. The rolling continued until the amount of free water became very small. No particular difference in the amount of rolling to effect this was noticeable for the limestone concrete and the gravel concrete. It was noticed, however, that the roller sank into the gravel concrete considerably more than into the rock concrete during the first one or two rollings.

TABLE I.—RESULTS OF TRANSVERSE TESTS OF CONCRETE SLABS FINISHED BY WOOD FLOAT AND BY ROLLER.

Specimen No.	Age at test, days.	Total applied load, lb.	Thickness,[1] in.	Kind of course aggregate.	Water used, percentage of volume of aggregate.	Modulus of rupture of concrete, lb. per sq. in. Medium consistency, wood-float finish.	Wet consistency. Wood-float-finish.	Roller finish.	Compressive strength of concrete (6 by 12-in. cylinders), lb. per sq. in.
1	15	3,300	5.20	Pebbles	15.9	301	...	...	.....
1a	15	3,200	5.14	Pebbles	15.9	302	...	...	2,370
2	15	3,200	5.18	Pebbles	18.6	...	294	...	1,760
2a	15	3,500	5.27	Pebbles	18.6	...	311	...	1,730
3	15	3,850	5.32	Pebbles	18.6	...	...	331	1,680
3a	15	3,400	5.07	Pebbles	18.6	...	...	325	1,680
4	15	4 000	5.25	Crushed limestone	15.9	353	...	...	2,130
4a	16	4,500	5.18	Crushed limestone	15.9	405	...	...	2,290
6	15	3,000	5.11	Crushed limestone	18.6	...	288	...	1,600
6a	16	3,750	5.20	Crushed limestone	18.6	...	340	...	1,680
5	15	3,650	4.87	Crushed limestone	18.6	...	...	378	1,330
5a	16	4,950	5.17	Crushed limestone	18.6	...	...	443	1,800
Average						340	308	369	

[1]Thickness of the slabs at the broken sections.

Note.—Concrete was machine-mixed in the proportion of 1 part cement to 4 parts aggregate, by volume. Size of slabs, 30 by 66 by 5 in. Loaded with dead weight at points 15 in. apart on 5-ft. span. Duplicate slabs were made on different days.

The roller used was $2\frac{1}{2}$ ft. long, 6 in. in diameter and weighed about 50 lb. In practical road work, an 8-in. roller about 6 ft. long, weighing about 70 lb., is recommended.

The forms were removed the following day, when the slab was covered with a layer of damp sand which was kept moist until the slabs were one week old. The sand was then removed and the slabs lifted from the floor and permitted to dry out during the remaining 8 days before the load was applied.

The slabs were placed on two supports spaced 15 in. on centers, resting on the floor. A ball bearing on the lower side of one support compensated for what warp there might be in the lower surface of the slab. The load, which consisted of 100-lb. sacks of sand, was supported by two 9-in. I-beams, and was transmitted to the slag through two bearings spaced 5 ft. apart. The upper surface of the slab was thus put in tension. Each test was made in the same manner, and as far as practicable the loads were applied at the same rate until rupture.

The appearance of the broken slabs disclosed a marked difference between those finished with the roller and those finished with the wooden float. The roller-finished slabs showed a distinctly denser appearance, extending for at least one-half the depth of the slab. It is to be noticed (see Table I) that the slabs tested when they were 16 days old show a consistent increase in strength over those 15 days old.

With the small number of test specimens, there are not sufficient data to determine definitely any special difference between the strength developed by the slabs made of pebbles and those with the crushed limestone. It is to be noted, however, that the pebbles used were somewhat irregular in shape, some pieces being broken.

The broken sections of all slabs, particularly those that were rolled, showed that many pieces of the coarse aggregate had been broken apart, the number of broken pieces being considerably greater in the rolled slabs than in those not rolled. There was no difference especially noticeable in this particular, between the slabs made of the limestone and those made of the pebbles.

The results of the tests are shown in Table I. The noticeable fact is that those slabs finished with the roller developed a very considerable increase in strength over the slabs merely hand-finished. The four slabs of wet consistency that were finished by hand, have an average modulus of rupture of 308 lb. per square inch, while the four slabs finished with the roller have an average modulus of rupture of 369 lb. per square inch, or an increase of almost 20 per cent. As would be expected, the slabs that were made of a stiffer mixture, indicated in Table I as medium consistency, giving an average modulus of 340 lb. per square inch, are stronger than those of the wet consistency, finished in the same manner; but the wet consistency slabs finished with the roller are stronger than those of the medium consistency, showing an increase of nearly 10 per cent.

The results seem to indicate clearly the value to be gained by the use of the roller to finish a concrete road; that it is possible by proper manipulation of concrete to secure increased strength and density of a character most desirable for a concrete road surface; and that such surplus water as may be required to facilitate placing concrete in road work can be effectively removed by this simple expedient.

A law has been passed in California which makes the use of highways by common carriers for either passenger or freight subject to regulation by the state railroad commission in the same way that railways are regulated. This law makes it necessary for any person or company proposing to engage in the jitney or motor trucking business as a common carrier to first obtain a permit from the governing body of each town, city and county in or through which it proposes to operate.

Detailed Cost of Bituminous Surface Treatment Work at Philadelphia

Bituminous treatment of the waterbound macadam highways of the city of Philadelphia was first started by the Bureau of Highways in 1912. At this time only a few roads were in a sufficiently good condition to warrant this treatment. In the last 3 years, however, the roads have been placed in such excellent condition that bituminous surface treatments have been applied to practically the entire yardage of macadam roads throughout the city. The dirt roads and a few cases where macadam roads are not in first class condition are given a treatment of dust laying oil, which, while it has but slight influence on the durability of the road, does act effectively as a dust layer.

During 1916, according to an advance copy of the annual report of Wm. H. Connell, Chief, Bureau of Highways and Street Cleaning, 185.58 miles of country roads were given bituminous surface treatments, and 116.48 miles were treated with a dust-laying oil. The detailed cost of the 1916 work is shown in the accompanying tabulation.

The first three years the Bureau applied surface treatment a continuous decrease in unit costs was obtained, the cost per square yard in 1913 being 7.3 ct.; in 1914, 5.8 ct., and in 1915, 5.03 ct. The decrease in cost was due both to the decreasing amount of materials required per square yard for surface treatment, to the increased efficiency of the working forces and the more effective planning of the work. The cost for 1916 amounted to 5.34 ct. per square yard, but this increase in cost was due largely to the increase in the cost of materials and the extraordinary labor conditions, which were not only responsible for the better men leaving the city employ for increased pay, but the unfortunate so-called independent lackadaisical attitude of the average laborer which has decreased his efficiency to a great extent. The cost of the bituminous materials increased on an average $.0021 per square yard, and the covering material increased an average of $.0001 per square yard, or a total of $.0022.

CHARACTER OF TREATMENT MATERIALS USED	TREATMENT	SQUARE YDS TREATED DURING 1916	AVERAGE MATERIALS PER SQ YARD		AVERAGE LABOR COSTS PER SQ YARD					AVERAGE MATERIAL COSTS PER SQ YARD			AVERAGE TOTAL COST PER SQUARE YARD	AVERAGE TOTAL COST PER SQ YARD FIRST AND RETREATMENTS			
			GALLONS BITUMINOUS MATERIAL	POUNDS OF COVERING MATERIAL	SWEEPING HAND	SWEEPING MACHINE	COVERING	CLEANING UP	TOTAL	BITUMINOUS MATERIAL	COVERING MATERIAL	TOTAL		1916	1915	1914	1913
REFINED COAL TAR — HOT APPLICATION—TARVIA A	1	39,212	348	18 4	0066	0024	0064	0020	0174	0295	0187	0482	0656	0612	0494	0641	0824
″ ″ ″ ″ ″ ″ ″	2,etc	57,023	294	16 4	0058	0013	0075	0022	0168	0246	0168	0414	0582				
REFINED COAL TAR — COLD APPLICATION —TARVIA B	1	211,827	428	17 4	0063	0016	0063	0018	0160	0299	0180	0479	0639	0485	0506	0566	0658
″ ″ ″ ″ ″ ″ ″	2	465 273	301	16 1	0032	0010	0052	0006	0100	0209	0168	0377	0477				
″ ″ ″ ″ ″ ″ ″	3	254,799	267	15 8	0032	0009	0052	0007	0100	0188	0163	0351	0451				
″ ″ ″ ″ ″ ″ ″	4,etc	350,250	240	15 8	0030	0008	0051	0006	0095	0168	0164	0332	.0427				
REFINED WATER-GAS TAR-HOT APPLICATION-UGITE	1	39,128	348	18.4	0066	0024	0064	0020	0174	0278	0187	0465	0639	0612	0501	—	.0943
″ ″ ″ ″ ″ ″ ″	2	9,821	319	15.9	.0026	0007	0050	0004	0087	0256	0164	0420	0507				
REFINED WATER-GAS TAR-COLD APPLICATION-UGITE	1	75,088	428	17.4	.0063	0016	0063	0018	0160	0274	0180	0454	0614	0511	0456	0509	0698
″ ″ ″ ″ ″ ″ ″	2	40,973	299	154	0024	0004	.0053	0004	0085	0193	0160	0353	0438				
″ ″ ″ ″ ″ ″ ″	4	40,807	315	162	.0011	.0002	0022	0006	0041	0201	0168	0369	0410				
″ ″ ″ ″ ″ ″ ″	5	3,500	200	160	—	.0002	0031	—	0033	0128	0165	0293	.0326				
ASPHALT CUTBACK	1	79,617	267	179	.0027	.0004	0068	0004	0103	0380	0178	0558	0661	0768	.0515	0738	.0868
″ ″	2	100,300	418	173	0038	0008	0077	0008	0131	0585	0162	0748	0879				
″ ″	3	32,753	362	18 0	0026	0008	0045	.0013	0092	0471	0181	.0652	0744				
″ ″	4,etc	41,024	320	179	.0033	0008	0046	0003	0090	0451	0181	0632	0722				
ASPHALT-150° PENETRATION-350° F	1	51,159	270	175	0037	0006	0091	0002	0136	0223	0178	0401	0537	0497	0461	—	—
″ ″ ″ ″ ″	2,etc	67,128	262	177	0032	0009	0064	0003	.0108	0208	0150	.0358	0466				
TOTALS (TARS AND ASPHALTS)		1,959,682	310	16 6	.0038	0010	0057	0009	.0114	0250	0170	0420	0534	0534	0503	0584	.0730
ASPHALT ROAD OIL—DUST LAYER— — 18° 23° BEAUME		1,230.045	246	—	—	—	—	—	—	0151	—	0151	0151	0151	0111	.0141	—
GRAND TOTAL (SQ YDS)		3,189,727	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Mostly Seal Coats on old Bituminous Roads

LABOR AND MATERIAL	UNIT COSTS -1916-	-1915-	-1914-	-1913-
TORPEDO GRAVEL, PER 2000 #, DELIVERED ON THE ROAD	$210	$203	$214	$250
TRAP ROCK CHIPS, PER 2000 #, DELIVERED ON THE ROAD	202	194	230	230
TARVIA A, PER GALLON APPLIED	085	085	085	085
TARVIA B, PER GALLON APPLIED	07	0692	07	.07
UGITE HOT, PER GALLON APPLIED	08	08	09	09
UGITE COLD, PER GALLON APPLIED	064	06	08	08
ASPHALT CUTBACK, PER GALLON APPLIED	1403	0791	.11⅔	.12
ASPHALT, 150 PENETRATION, PER GALLON APPLIED	0795	0791	—	—
ASPHALT ROAD OIL, PER GALLON APPLIED	0588	0484	0523	—
LABORERS, PER 8 HOUR DAY	200	200	200	200
FOREMEN, PER 8 HOUR DAY	400	400	400	400
ASST FOREMAN, PER 8 HOUR DAY	300	300	300	300
TEAMS, PER 8 HOUR DAY	480	448	475	520

AVERAGE LABOR COST, PER SQ YD., FOR HAND & MACHINE SWEEPING, CHIPPING & CLEAN UP DURING	1915	.0105
″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″ ″	1916	0114
INCREASE		.0009

SUMMARY
MILES OF ROADWAY TREATED 1916 (18' WIDE)

REFINED COAL TAR — HOT APPLICATION — TARVIA A	912	Miles
″ ″ ″ — COLD ″ TARVIA B	1214 2	″
REFINED WATER-GAS TAR — HOT APPLICATION — UGITE	464	″
″ ″ ″ ″ COLD ″ ″	1519	″
ASPHALT CUTBACK	2401	″
ASPHALT, 150 PENETRATION, 350° F	1120	″
TOTALS (TARS & ASPHALTS)	18558	″
ASPHALT ROAD OIL	11648	″
GRAND TOTALS	30206	″

	SQ YDS	COST PER SQ YD
ROADS COVERED BY MEANS OF HORSE DRAWN SPREADERS	180,213	00274
ROADS COVERED BY MEANS OF SHOVELS - HAND SPREADING	1,779,469	00601
REDUCTION IN LABOR COSTS OF COVERING PER SQ YARD, DUE TO SPREADER		00327

ALL CLASSES MATERIALS 1916
- TOTAL GALLONS APPLIED — 910,056 GALS
- TOTAL AMOUNT COVERING MATERIALS — 16,245 4 TONS
- TOTAL COST — $100,896 01

Summary Showing Detail Cost of Bituminous Surface Treatment Work in 1916, by the Bureau of Streets of Philadelphia.

Patrol Work on N. Y. Highways

During 1916 the New York State Highway Department maintained by the patrol system, 5,459 miles of low grade concrete and macadam pavements and gravel surfaces at a cost for labor and material of $654,746. In his last annual report Mr. Fred W. Sarr, Second Deputy Commissioner, comments as follows on this method of maintenance: The efficiency of the patrol system as compared with the gang system has been questioned, and in sections where a gang can be operated to advantage the patrol system has been suspended for a time and while the gang would unquestionably perform more efficient work than the average patrolman, it was found that the greater efficiency was more than offset by the greater magnitude of the work required to be performed. This statement is qualified by the old saying that "A stitch in time saves nine," and it was found that the patrolman who was over the road every day could perform the one stitch in less time and at less cost for material than where the same number of men were combined in a gang, with a necessarily greater mileage of highways to maintain, and by reason of the larger mileage that the attention to each section of highway was perhaps at intervals of several weeks, when the nine stitches were then required, which more than offset the efficiency of the work of the gang as compared with the average individual patrolman.

Soil Texture and Stratification Affecting Road Foundations

By CHAS. R. THOMAS,

Assistant Engineer, Construction Service Co.,
New York

Road foundations are largely controlled by drainage and soil conditions of the immediate locality.

Texture and Structure of Soils.

Soil texture has reference to the size of the soil particles and the proportions in which they are arranged in the soil. Variations in soil textures distinguish soils, as loam, clay, sand, etc.

Soil structure has to do with the arrangement of the soil particles, which is in turn affected by organic matter and water content.

Surface soil usually contains ordinary organic matter.

Subsoil contains little organic matter.

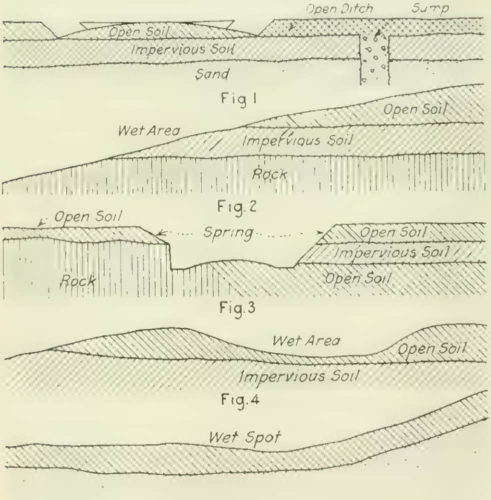


Fig 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Figs. 1-5—Arrangement of Soil Structures.

Water exists in soil under three conditions, (1) gravitational, (2) capillary and (3) hygroscopic.

The natural movement of gravitational water is downward, but this may be affected by the location and texture of the subsoil.

Capillary movement is due chiefly to surface tension between the soil particles. Surface tension is a function of size of the soil particles. The direction of capillary movement along the surface of the particles is always toward the point where the water has been removed.

Hygroscopic water exists in the soil after it is air dry, the amount of hygroscopic water present depending on (1) fineness of the soil particles, (2) temperature of the soil, (3) temperature of the air in the soil and (4) the organic matter in the soil. Clay contains a large amount of hygroscopic water. The movement and quantity of hygroscopic water depends largely on the temperature.

Soil Stratification and Drainage.

There are three general methods of overcoming poor drainage conditions:

(1) By raising the grade line.

(2) Tile drainage.

(3) Providing an artificial base under the road.

As a rule the first method is most satisfactory, the second method is lowest in first cost on a large scale and the third method is generally used for small areas where the grade cannot be raised.

Flat Undrained Areas.—In flat low-lying areas where the water does not stay long upon the ground an examination with a spade or auger will generally show that the water-table is within 2 ft. and frequently only a few inches below the surface. Fig. 1 illustrates this condition. The difficulty is usually due to an underlying stratum of impervious material.

Springy Areas upon Slopes.—Springs are frequently encountered upon slopes or in cuts. The explanation is generally quite simple and the method of correction obvious. A wet area (a-b, Fig. 2) may appear or a well-developed spring may exist. This condition is frequently encountered in limestone sections.

Ponds Without Outlets.—A small wet area (Fig. 3), such as frequently encountered in glacial drift areas, should be noted.

Wet Spots in Flat Areas.—Frequently wet spots are encountered in flat areas or at the foot of hills. This may be caused by water under pressure (Fig. 4).

Handling Hillside Slips

By far the largest problem which has presented itself, in the way of repair of the National Road in Ohio, has been the handling of hillside slips. Many of them were giving trouble when the work of reconstructing the road was started 3 years ago. Others were started when the equilibrium was disturbed by new grading. On a railroad it is possible to fill up or remove a slip year after year without causing any great inconvenience. This policy could not be pursued here, however, as an expensive piece of pavement is destroyed every time the roadway slips. As no two slips are ever alike, the method of dealing with each one must be separately determined. Three principal means have been employed to date in dealing with this situation. The first one tried was to trench down to the slipping surface, which is usually on a fireclay, and install enough drains to keep the water from reaching the impervious strata. As this required an open trench, which might be many feet deep, and a great quantity of stone for drainage purposes, the expense was very high. Where the slips are shallow and cover an extensive area, the plan of roughening the slipping surface, by shooting with dynamite at frequent intervals, has proven satisfactory. This has seemed to work especially well where the surface on which the slip occurs is rock. The other method has been tried only recently. This consists in driving piling wherever the condition of the soil will permit. So far it has been cheaper than the system of drainage.

Officials of the U. S. Forest Products Laboratory recently made a trip to 15 cities in Texas with the object of studying failures and partial failures of wood block pavement. It was found that the failures occurred in those pavements which were constructed on sand cushion and with sand fillers, whereas those constructed on mortar cushion with bituminous fillers were giving no trouble. Failures were practically all due to the development of expansion trouble. It was found that the oil used to treat these blocks was not an important factor.

How Philadelphia Conducted an Educational "Clean Streets" Campaign

An extensive and intensive educational clean streets campaign was conducted last year at Philadelphia, Pa. The primary objects of this campaign were to instruct the citizens in the city laws and ordinances relating to preventive street cleaning and to warn them of the coming enforcement of these laws by the police. The following description of the campaign is abstracted from an advance copy of the report of William H. Connell, Chief Bureau of Highways and Street Cleaning, covering the year ending Dec. 3, 1916:

The campaign was opened with a mass meeting called by the mayor, the director Department of Public Works, the chief of the Bureau of Highway and Street Cleaning, the Chamber of Commerce and the United Business Men's Association. Formal invitations to attend were sent to the officers of the several business men's improvement and civic associations throughout the city, requesting that they send at least three delegates to this meeting.

Following the mass meeting, a clean streets committee was appointed composed of representatives of the Philadelphia Chamber of Commerce, the United Business Men's Association, the Civic Club of Philadelphia, and the Poor Richard Club. The director of the Department of Public Works and the chief of the Bureau of Highways and Street Cleaning represented the city of Philadelphia.

The first step in the campaign was the issuance of a general order by the Department of Public Safety and the Superintendent of Police, calling attention to the several laws governing clean streets and gutters incidental thereto, and indicating that they would thereafter strictly be enforced.

This was followed by the printing of 400,000 notice cards which contained a brief statement of the objects of the campaign and a series of statements in the form of "Don'ts" emphasizing the salient features of the existing clean streets laws, which the citizens would thereafter be required to observe. On the reverse side of this notice card was printed extracts from the existing laws, together with the penalties for their violation, accompanied by the admonition "To Avoid Error, Know the Law, to Avoid the Penalty, Obey the Law." These notice cards were distributed to the several district police stations and were served by the patrolmen personally on a responsible occupant of every home and other buildings throughout the city.

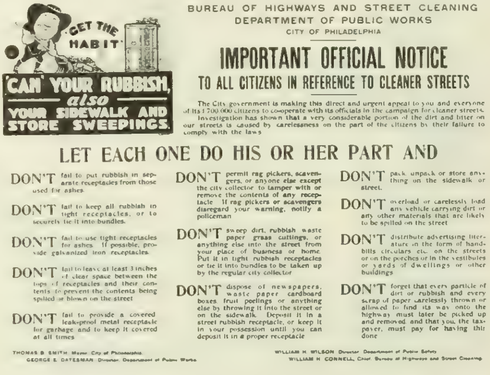
Attractive large placards, printed in black and red, outlining the purpose of the campaign and featuring the "Don'ts" were designed and 31,500 placed in store windows, railroad stations, factory buildings and other prominent locations throughout the city. Two of these placards were also placed in every trolley car operated by the several traction companies in the city of Philadelphia. The trolley car placards contained on the reverse side a large cartoon, which, when the placards were fastened to the car windows, could be seen from the street and gave added value to this means of publicity.

Personal letters were sent to the executives of the several public service corporations and the large business concerns operating in the city, explaining the purpose of the campaign and requesting their co-operation in bringing the matter to the attention of their employes, and also where necessary enforcing better housekeeping methods with respect to the matter of clean streets on the property under their control.

From the very beginning of the campaign and extending throughout its course, enthusiastic co-operation was given the movement by the several newspapers of the city in publishing daily accounts of the progress of the campaign and appealing to the citizens to assist the city officials in their efforts to improve the appearance of the streets. A number of neighborhood newspapers also made a special feature of the clean streets campaign and gave it considerable publicity.

Poster stamps, 300,000 in quantity, printed in blue and gold—the city colors—containing a cartoon showing William Penn sweeping and "Get the Habit" were distributed to the several municipal departments and also to a number of business and civic organizations, who attached them to their outgoing correspondence.

Warning letters were drafted and sent to the several classes of persons or agencies whom it was found were habitually violating the laws. Among these were distributors of advertising literature, contractors owning or having control over vehicles transporting dirt and other fragmentary materials through the highways, and storekeepers who made a practice of placing store sweepings or rubbish on the highways.


GET THE HABIT
CAN YOUR RUBBISH,
also
YOUR SIDEWALK AND STORE SWEEPINGS.

BUREAU OF HIGHWAYS AND STREET CLEANING
DEPARTMENT OF PUBLIC WORKS
CITY OF PHILADELPHIA

IMPORTANT OFFICIAL NOTICE

TO ALL CITIZENS IN REFERENCE TO CLEANER STREETS

The City government is making this direct and urgent appeal to you and everyone of its 1,700,000 citizens to co-operate with its officials in the campaign for cleaner streets.

Investigation has shown that a very considerable portion of the dirt and litter on our streets is caused by carelessness on the part of the citizens by their failure to comply with the laws.

LET EACH ONE DO HIS OR HER PART AND

DON'T fail to put rubbish in separate receptacles from those used for ashes.

DON'T fail to keep all rubbish in tight receptacles, or to securely tie it into bundles.

DON'T fail to use tight receptacles for ashes. If possible, provide galvanized iron receptacles.

DON'T fail to leave at least 3 inches of clear space between the tops of receptacles and their contents to prevent the contents being spilled or blown on the street.

DON'T fail to provide a covered leak-proof metal receptacle for garbage and to keep it covered at all times.

DON'T permit rag pickers, scavengers, or anyone else except the city collector to tamper with or remove the contents of any receptacle. If rag pickers or scavengers disregard your warning, notify a policeman.

DON'T sweep dirt, rubbish, waste paper, grass cuttings, or anything else into the street from your place of business or home. Put it in tight rubbish receptacles or tie it into bundles to be taken up by the regular city collector.

DON'T dispose of newspapers, waste paper, cardboard boxes, fruit peelings or anything else by throwing it into the street or on the sidewalk. Deposit it in a street rubbish receptacle, or keep it in your possession until you can deposit it in a proper receptacle.

DON'T pack, unpack or store anything on the sidewalk or street.

DON'T overload or carelessly load any vehicle carrying dirt or any other materials that are likely to be spilled on the street.

DON'T distribute advertising literature in the form of handbills, circulars, etc., on the streets or on the porches or in the vestibules or yards of dwellings or other buildings.

DON'T forget that every particle of dirt or rubbish and every scrap of paper carelessly thrown or allowed to find its way onto the highway must later be picked up and removed, and that you, the taxpayer, must pay for having this done.

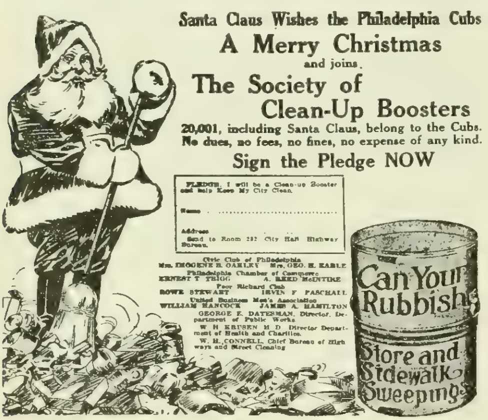
THOMAS B. SMITH, Mayor, City of Philadelphia.
GEORGE E. DATESMAN, Director, Department of Public Works.
WILLIAM H. WILSON, Director, Department of Public Safety.
WILLIAM H. CONNELL, Chief, Bureau of Highways and Street Cleaning.

Publicity Placard Used in Connection with the Clean Streets Campaign.

After the campaign had been underway for about a month a special force consisting of twelve inspectors, and an inspector in charge, was assigned to educational work in the sections of the city where it was thought this would be most advantageous. These inspectors were especially instructed in their duties and conducted a house to house canvass, explaining to the occupants the purpose of the campaign for clean streets, the requirements of the laws and enlisting their co-operation in observing the laws and in providing approved types of receptacles for ashes, rubbish and garbage.

In general it was found that carelessness on the part of householders and others was due principally to two reasons: First, because of ignorance of the existence or the requirements of the law, as the laws were never enforced; and, secondly, when persons were conversant with the laws they invariably stated they had become careless because of the fact that there seemed to be no effort made to enforce their provisions. Everyone, however, seemed to be in hearty accord with the necessity and desirability of enforcing the laws. On the whole, the citizens were found willing to co-operate with the city authorities and it was only necessary to institute legal proceedings against a very few who remained obstinate and refused to discontinue practices which violated the laws. Later on in the campaign a policeman in uniform was detailed to assist the education squad and the results of his work were very gratifying, as some people who would pay little or no attention to the advice of the inspectors would obey at once the representative of the law in uniform.

Through the co-operation of the superintendent of public schools and the superintendent of parochial schools, a series of six statements, expressed in simple but effective style, were issued to every teacher in the public and parochial schools throughout the city. Each of these statements dealt with a specific matter in connection with the clean streets campaign and was read and explained to the school children during successive weeks in connection with the course in civics.


Santa Claus Wishes the Philadelphia Cubs

A Merry Christmas

and joins.

The Society of Clean-Up Boosters

20,001, including Santa Claus, belong to the Cubs.
No dues, no fees, no fines, no expense of any kind.

Sign the Pledge NOW

PLEDGE. I will be a Clean-up Booster and help Keep My City Clean.

Name ....

Address

Send to Room 282 City Hall Highway Bureau.

Civic Club of Philadelphia
Mrs. IMOGENE B. OAKLEY Mrs. GEO. H. EARLE
Philadelphia Chamber of Commerce
ERNEST T. TRIGG A. REED McINTIRE
Poor Richard Club
ROWE STEWART IRVEN F. PASCHALL
United Business Men's Association
WILLIAM HANCOCK JAMES A. HAMILTON
GEORGE E. DATESMAN, Director, Department of Public Works
W. H. KRUSEN, M. D., Director Department of Health and Charities
W. H. CONNELL, Chief Bureau of Highways and Street Cleaning

Newspaper Advertisement Used in Connection with the Society of Clean-Up Boosters.

Realizing that the subject of clean streets is a dry matter to the average citizen and that the public is usually inclined to criticise the government rather than be reminded of their faults, it was thought advisable to adopt a means of publicity calculated to arouse the lively interest of everyone. Therefore, an organization, entitled the Society of Clean-Up Boosters, familiarly known as the "C U B S" was formed and the general public invited to become members through a series of attractive paid advertisements which appeared in each of the five morning newspapers on six consecutive Mondays. The advertisement which appeared on Christmas morning showed a sketch of Santa Claus engaged in sweeping up rubbish and placing it in an approved receptacle and stated that "Santa Claus wishes the Philadelphia Cubs a Merry Christmas and Joins the Society of Clean-Up Boosters." The last of the series appeared on New Year's morning and admonished all to start the New Year right by joining the CUBS. Through the medium of this society, the Clean Streets Campaign has been brought to the attention of many thousands of citizens in a unique and effective manner. The membership of the organization is based upon the prospective member signing a pledge to be "A CLEAN UP BOOSTER AND TO HELP KEEP MY CITY CLEAN." The pledges were designed especially to attract attention and contained, in addition to the previously described cartoon and slogan symbolizing the campaign, the admonition to "sign the pledge and help your city" and explained that there were "no dues, no fines, no expense of any kind to belong to the Society of Clean-Up Boosters." Upon receipt of this signed pledge at the Bureau of Highways and Street Cleaning, a letter of instruction accompanied by a code of laws governing clean streets and matters relating thereto, and a badge of membership in the society was sent to the signer of the pledge.

Every practicable means was employed to give publicity to the Clean Streets Campaign and in additiion to the methods already described, requests for cooperation were read in the churches throughout the city and posters and slides containing a cartoon and slogans and requesting co-operation were shown in the moving picture theaters. Department and other stores were also encouraged to hold special sales of approved types of ash, rubbish and garbage receptacles.

The first stage of the intensive Clean Streets Campaign, which was educational in nature, served its purpose. It is thought through the several means of publicity which have been employed that the responsibility of the individual in the matter of clean streets has been brought to the station of each and every citizen.

Though it is not possible to indicate the results of the campaign in concrete figures, yet there is no doubt that the expenses and effort expended have been fully justified by the interest that has been aroused and the improved conditions which have been noted in all sections of the city, and it is hoped that the improvement which has only begun may not only be developed consistently until the desired results have been fully accomplished, but that the laws and ordinances relating to Preventive Street Cleaning will no longer be a dead letter but will be continually enforced.

Frames Facilitate Unloading of Asphalt Paving Blocks

In connection with its paving work in New York City, the Hastings Pavement Co. ships a large percentage of the asphalt blocks by scows and canal boats to the dock nearest the job on which the blocks are to be used. To unload the blocks from the boat, a block frame has been devised that will fit into the ordinary bottom dumping truck. The frames are loaded with blocks from the boat and hoisted with a catamaran and placed in the trucks where the blocks and frames are carried to the street and the blocks unloaded. The empty frames are returned with the truck and again loaded with more blocks. Three to five loaded frames make a truckload. A small 4 wheeled truck is used for moving the loaded block frames from different parts of the boat to the place of hoisting. This method saves considerable labor over the old method of passing or carrying the blocks across the boat. By this method a 5-ton truck can be loaded in a few minutes. There also is a further saving in labor in case of delay at the street in getting the trucks unloaded, as the laborers at the boat can be filling extra frames ready to be hoisted onto the trucks when the trucks return to the boat. For hoisting of a catamaran equipped with gasoline engine capable of lifting 1,600 lbs. per lift is used.

The city of Philadelphia, Pa., has just awarded a $325,000 contract for a 1½-mile extension of Northwest Boulevard. The McMichal Co., Philadelphia, received the work.

Standards for Plans for Federal Aid Road Projects

Standards governing the form and arrangement of plans, specifications and estimates for road projects to be carried out under the Federal Aid Act have been prepared by the U. S. Office of Public Roads and Rural Engineering in co-operation with a committee of the American Association of State Highway Officials, consisting of W. D. Uhler, Chief Engineer Pennsylvania State Highway Department; A. W. Dean, Chief Engineer Massachusetts Highway Commission, and W. W. Marr, Chief Engineer Illinois State Highway Department. Plans and specifications for the various projects are to be initiated and prepared by the State Highway Department in conformity with these standards. The standards, which will govern all Federal aid road projects for which statements are submitted after Sept. 30, 1917, go into considerable detail as to the form and substances of plans. For the specifications, however, only the required outline and arrangement are given. The requirements for form and arrangement of plans follow:

Plans.

The plans will consist of a title-page, typical cross section of improvement, plan and profile, cross sections and such structural plans and state structural standards as may be necessary to properly show the proposed construction.

Sizes.—All plans or drawings will be on flat sheets 22 by 36 in. outside dimensions. Border lines are to be so placed as to provide a binding margin 2 in. wide at the left-hand end and a margin ½ in. wide on the remaining three edges of all plans. On cross-section sheets the border lines may be omitted, but sufficient space should be allowed for the 2-in. binding edge at the left-hand end of the sheets. State highway department standard sheets, showing structural standards, may be made a part of the plans and be attached thereto, provided the size of these standard sheets does not exceed the size required for plans.

Notations.—The plans are to be based upon suitable surveys, and all notation necessary to make the required details clear is to appear appropriately throughout the plans.

Any information which the State highway departments may deem necessary for their own uses may be incorporated in the plans, in addition to that herein prescribed, provided it does not interfere with their legibility.

Submission.—The sheets composing the set of plans should be bound in the following order: Title-page, typical cross-section of improvement, road plans, State standards, special structural plans and cross sections.

Blue prints of all plans, with the exception of cross sections, are to be submitted in triplicate, one copy of which will be returned when approved. Blue prints of cross sections are to be submitted in duplicate. The necessary additional copies of bridge plans are to be submitted upon request of the Office of Public Roads after plans are approved. Each copy of a set of plans should be accompanied by a copy of the specifications.

Title-Page.—The title-page for the set of plans shall show, conveniently arranged, the title, scales, a layout map, an index of the drawings, a key to the conventional signs used, the number of the project in the upper right-hand corner, and, in the lower right-hand corner, a sufficient number of blank spaces for the dates and signatures of the approving State officials, and blank spaces for the dates and signatures of two approving Federal officials with their titles.

The layout map shall show the layout of the project, indicating county and State lines where contiguous to the road, north point, principal connecting and adjacent roads, principal streams, railroads, cities and towns, and shall be of such scale as to permit its being shown on the title-page.

Typical Cross Section of Improvement.—A typical cross section of the improvement shall be placed on the first sheet directly following the title-page. This section, on a suitable scale, should show the various slopes for cut and fill, the width of graded section in cut and on embankment, the crown or shape of the finished surface, shoulders, gutters, etc., between slopes, the width and thickness of the various courses of pavement or surfacing, and the position of the profile grade line relative to the typical cross section, together with any desired additional details.

When more than one typical cross section is used, the proposed location for each should be indicated.

On this sheet also may be shown, if desired, any special information, such as summary of quantities, etc.

Road Plans.

Arrangement.—The plan and profile shall be placed on the same sheet. The plan shall be shown across the top of the sheet and the corresponding profile directly below. When the conditions permit, without interference or overlapping, two sections of the plan and profile may be shown on the same sheet.

A suitable standard profile ruling may appear across the lower portion of the sheet if desired, but the upper portion showing the plan should in no case bear profile ruling.

Scales.—The plan shall be drafted to a scale of 1 in. = 100 ft., or 1 in. = 50 ft., at the option of the State highway department, and the profile shall be drafted to the same scale horizontally as the plan and to a scale of 1 in. = 10 ft. vertically.

Data on Plan.—The plan of the road shall show the center line of construction, bearing of tangents, right-of-way lines, stations of beginning and ending of curves, length of curves, approximate radii of curvature, station points, equations of stationing streams, and railroads on or near the right of way, poles for wire lines, obstructions on the right of way, structures affected by the proposed construction, the location of proposed new culverts and bridges with their sizes, any old road surfaces or portions of pavements to be used in place in connection with the proposed construction, and all unusual or special features which can be anticipated, such as guardrail, retaining walls, ditch protection and subdrains. Such of these items as lend themselves readily to location by description may be tabulated or noted, but the tabulation or notation should appear on each sheet of the plan concerned. In minor changes of location requiring new or additional right of way, the margins of the old roadway shall be shown by light broken lines.

The plan should be platted with the stationing from left to right. A north point should be placed on each sheet. All curve points and angles on the construction line should be marked by small circles and the 100-ft. station points by a very short line drawn at right angles to the center line.

Data on Profile.—The profile is to show surface line, grade line, length of vertical curves, percentage of gradient, datum line, station ordinate lines, surface elevations and grade elevations at station ordinates, and changes of gradient. The surface line of stream beds under existing bridges, as well as that of the bridge floors, should be shown.

The "grade line" shall represent the profile of the surface of the finished pavement or surfacing along the center line of the proposed construction.

The "surface line" shall represent a profile of the surface of the ground along the center of the present traveled way where the new location of the roadway is to be essentially the same as the old location, although the centers may deviate slightly. Where relocations or realignments are made which will cause the center line of the new roadbed to be essentially different from the center of the present traveled way, the surface line shall represent a profile of the ground along the center of the proposed roadway. The surface line is to be drawn as a series of straight lines.

Cross Sections.—Cross sections taken at intervals not exceeding 100 ft. shall be plotted to a scale of 1 in. = 5 ft., vertically and horizontally. They should be plotted from the bottom of the sheet upward and so as not to interfere unduly with one another. As these sheets are to be bound on the left-hand end, either the lower side or the right-hand end of the sheets may be used as the bottom in plotting. The sections should show the ground surface and the templet lines for the proposed construction. Each section should be marked with its station location and "grade-line" elevation. Any desired additional information such as area, yardage between sections, etc., may be shown.

Structural Plans.

Structural plans shall be submitted as indicated under the following conditions:

(1) For culverts or drainage structures with clear spans not exceeding 20 ft., measured along the center line of roadway, there shall be submitted either complete detail plans or standard plans giving all essential information. If standard plans are used, they should be bound with the plans for each project and not used by reference only.

(2) For bridges with spans exceeding 20 ft., the complete set of plans shall contain the following: Plan of bridge site, profile of crossing, cross sections, complete stresses, design and general details, shop and all minor details, and such other drawings as may be essential to make the information complete and intelligible. While it is expected that plans will be submitted and approved and project agreements executed before bids are requested, the following exceptions will be allowed:

(a) Shop and minor details may be submitted after the contract is awarded but before work is begun on materials.

(b) When it is impracticable, as sometimes occurs in the case of movable spans, to submit plans and specifications previous to receiving bids, such plans and specifications may be submitted after bids are received, provided the State highway department shall notify the Office of Public Roads in advance as to all the steps to be followed in securing such bids, in the same manner as if the project agreement had been previously signed.

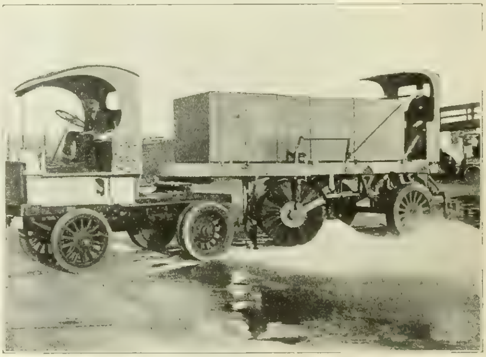
(3) For bridges requiring the approval of the Secretary of War, data required by him should, if practicable, be submitted for approval prior to its submission to the War Department. The remaining plans should be submitted as herein called for after authority has been granted by the Secretary of War.

When designs for culverts and bridges are submitted, they should be accompanied by three sets of specifications.

Work of Street Cleaning Department of New York City

Improvement in organization, equipment and methods by the Street Cleaning Department of New York City has brought marked results in the way of increased service and lessened cost. The cost of the regular work in 1916 was the lowest in 6 years. The per capita cost of regular service was 20 ct. less for the last 3 years than for the previous 3 years, according to the annual report for 1916 of J. T. Fetherston, Commissioner of Street Cleaning, made public on June 7. Extracts from the report follow:

The Physical Problem.—The Department of Street Cleaning serves a resident population in excess of five millions and a fluctuating transient population averaging close to another million. In the three boroughs under its jurisdiction, there is an area of 140.2 square miles and 302,294 buildings—an increase since 1915 of 5,540 buildings. The maximum density of population per acre in the most thickly populated ward (lower East Side of Manhattan) is 696.7; minimum density (outlying Brooklyn) is 3.2; average density for the three boroughs 78.1. In the three boroughs there were 101,723 horses and 89,122 automobiles, commercial and pleasure, in 1916. The increase in the number of automobiles over 1915 was 26,217, or more than 40 per cent in one year. There was an increase of 37 per cent over 1915 in the number of commercial motor vehicles in the city. This increase not only represents a remarkable growth in street traffic for business purposes, but strikingly demonstrates the tendency to substitute the motor for the horse in heavy hauling. It also suggests that the Department of Street Cleaning, one of the city's heaviest haulers and its largest horse owner, must motorize its equipment if it is to keep abreast of the times. The number of horses in the city was practically the same in 1916 as in 1915.



Combination Flushing and Sweeping Machine Operated by Electric Power from Tractor.

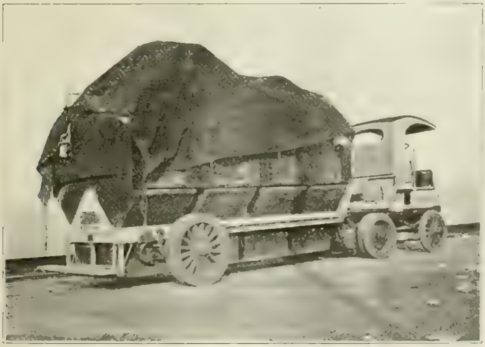
Department Equipment.—Since 1914 there has been a considerable change in the equipment employed by the Department. The changes generally represent improved methods of performing functions. The introduction of motor equipment has increased the efficiency of operation more rapidly than the growth in the amount of work to be done, as is evidenced by the decrease in the number of horses used by the Department. The increase in the number of sweepers' can and paper and refuse cans represents, especially in the case of the latter, a more thorough provision for the care of street dirt and litter. The great increase in the hose equipment finds its explanation and justification in the program of widely extended flushing, to which reference is made elsewhere in this report.

Table I presents a list of articles of equipment on Dec. 31, 1916, as compared with Sept. 30, 1914, at the time the first inventory under the present administration was completed. Equipment used in snow work is not included in this table.

TABLE I. MAIN ITEMS OF EQUIPMENT, SEPTEMBER 30, 1914, AND DECEMBER 31, 1916.

Items	1914.	1916.	Gain and loss. 1916. Increase.	Gain and loss. 1916. Decrease
Horses	2,522	2,346	...	176
Buggies	70	96	26	...
Steel dump carts	2,252	2,240	....	12
Steel dump trucks	113	81	...	32
Paper carts	452	452	....	...
Paper trucks		67	67	...
Double platform trucks	25	28	3	...
Single express wagons	25	24	.....	1
Bottom dump wagons	20	108	88	...
Street sweeping machines	149	149	....	...
Squeegees	11	26	15	..
Street sprinklers	106	123	17	...
Gasoline-electric tractors	......	12	12	...
Electric tractors	......	2	2	...
Gasoline tractors	.	1	1	...
Gasoline trucks	..	1	1	...
Collection trailers	.	19	19	...
Street flushing (gasoline) machines	5	4	...	1
Combination containers	......	30	30	...
Steel refuse containers	......	130	130	...
Drag scrapers	15	19	4	...
Bicycles	136	169	33	...
Sweepers' cans	13,860	18,686	4,826	...
P. & R. cans	965	3,952	2,987	...
Can carriers	3,954	3,183	...	771
Asphalt scrapers	4,172	3,646	....	526
Flushing hose, 2-in., 50-ft. length	355	770	415	...
Flushing hose, 2½-in., 50-ft. length (in all boroughs)	....	321	321	...

The Department Force.—There was a slight increase, approximately 1.29 per cent, in the size of the force of the Department in 1915 over 1914. In 1916, despite the increase in population and enlargement of territory, requiring additional service from the Department, the force was reduced 8 per cent. This large reduction in the force during the past year is attributable to the substitution of motorized for horse-drawn equipment in the Model District, reorganization of the supervising branch of the force in the field, and reduction of number of employes in the Mechanical Division. The total number of regular employes on the rolls for the three years, respectively, was as follows: 1914, 6,978; 1915, 7,068; 1916, 6,523.

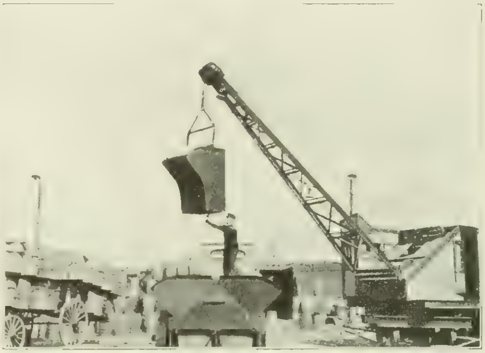


Hauling 25 Cu. Yd. of Refuse per Trip. Garbage, Ashes, Street Sweepings and Rubbish in Separate Compartments.

On Jan. 1, 1916, a merit system of apportioning wages in the various classes was put into effect. Regular drivers, who had formerly received a flat rate of $800 a year, were placed in five grades, the wages ranging from $768 to $864. Regular sweepers, whose old rate was $780, were graded from $720 to $792. Extra drivers were advanced from $2 to $2.40 per day, and extra sweepers from $2 to $2.30 per day. The schedules for hostlers, stablemen and dump boardmen were also readjusted on lines of the merit system, with increased compensation for the higher grades.

Schedules for 1917 comprehend advances which will give the following wages for first grade men: Regular drivers, $888 per year; extra drivers, $2.60 per day; regular sweepers, $816 per year; extra sweepers, $2.50 per day; hostlers, $840 per year; stablemen, $840 per year; dump boardmen, $840 per year; auto drivers, $924 per year, and trailer loaders, $840 and $864 per year.

Model District.—The most far-reaching feature in the program of equipment improvement was embodied in plans for the "Model District." The Board of Estimate and Apportionment appropriated $250,000 for this purpose and District No. 6, Manhattan, was selected as the field in which to work out the new plans of the Department. Believing this district with its modern equipment would be accepted as a model to be copied in other and, eventually, in all of the districts, the head of the Department christened it the "Model District."



Unloading Compartments Containing Refuse by Electric Crane.

Adoption of Motor Power.—The first step taken in remodeling the district was to devise plans and apparatus operated by motor power to displace the horse-drawn vehicles and cleaning by hand, so far as practicable. The engineering division of the Department undertook the task of designing the principal pieces of apparatus required for the economical working out of the newly-devised methods. A gasoline-electric tractor was designed by the Department's engineering division and after construction and trial was found to meet requirements. During 1915 twelve of these tractors were completed and made ready for service, at a cost of $4,166 each. Trailers, to be drawn by the tractors, and combining facilities for collecting in separate compartments, ashes, street sweepings, garbage and rubbish, were also designed and constructed. These trailers provide for the collection of the four classes of material on the same trip, whereas, the old horse-drawn cart requires three distinct trips for the task. In addition to this apparent economy, each trailer carries an amount of waste material equal to eight cart loads. Eleven of the trailers were constructed during 1915 at a cost of $810 each.

During 1916 seven additional tractors and six trailers were added to the Model District equipment, and of those constructed in 1915, two tractors were transferred to Brooklyn and one to the Bronx, leaving 16 tractors and 18 trailers for Model District service.

Further motorization of the Model District equipment was accomplished in 1916 by the installation late in the year of a combination flusher-sweeper, which was also designed by the Department's engineering division. This machine flushes and sweeps the street pavement in one operation, thus not only enhancing the quality of those branches of the service, but doing so economically. Three more of these combination machines are in course of construction and will be ready for use when weather conditions will permit of flushing. Other equipment in the Model District has been made to conform to the motorized collection methods, by the installation of locomotive cranes, for transferring trailer loads to scows, and by advancing all contingent apparatus and methods to the higher plane.

Approximately $68,000 was saved to the city by this modern equipment in 1916, as compared with 1914, the last year in which horses exclusively were used for collection in the district.

The Model District has fulfilled the promises made for it. Though it is not yet complete in all its details, it has progressed sufficient to prove beyond all doubt that motorized equipment and the accompanying improved methods produce enhanced service, at reduced cost. Accepting this testimony as a guide, the Board of Estimate and Apportionment has provided, in the budget for 1917, for the motorization of two more districts.

Increase in Flushing.—Extension of street flushing has been a cardinal feature of the present administration's program since taking office. During 1914 advance in this direction was slow, as the plans for the year were made during the fall of 1913, and, further, as there was only a limited amount of water and hose available for the purpose. In 1915, after a careful study of the subject, in co-operation with the engineers of the Water Department, the methods employed were markedly improved, and along scientific lines. The amount of flushing was increased 30 per cent over 1914. Improvement in the manner of handling and caring for the hose, with coincident training of the men, resulted in better service and economy in the use of water and equipment. A standard practice was installed and the men were carefully drilled in the best methods of performing the work.

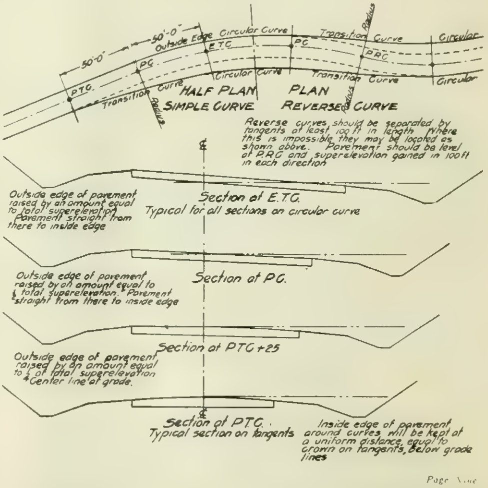
In 1916 still further improvements in flushing were made. The hose gangs were increased to 200 and, so far as funds would permit, greater and improved equipment was supplied. During the year increase in the area flushed and washed was extended until, in the summer and fall months, practically every street in Manhattan, and most of the important or congested thoroughfares in Brooklyn and The Bronx, were cared for by hose, squeegees, or sprinkling carts and machine sweepers, at least once in every twenty-four hours. While infantile paralysis was prevalent last summer and autumn and extra precautions were being taken in every direction, the pavements in the congested sections were flushed frequently, in some instances two or three times during a day. Especial attention was given to those streets in which there were push-cart markets.

Ohio Practice in Widening and Super-Elevation of Pavements on Highway Curves

As a means for promoting safety the State Highway Department of Ohio has decided to both widen and superelevate pavements on curves in the future construction of state highways. The method of carrying out this work is described by Mr. John W. Graham, Division Engineer of the Ohio State Highway Department, in the June issue of the Concrete Highway Magazine from which the following notes are taken:

Widening.—The average construction in Ohio provides for a 16-ft. pavement on a 26-ft. road bed. The standards for extra widths on curves were prepared for the above conditions, but will apply to practically all conditions, except where single track (10-ft.) roads are built.

Additional width placed on the outside of curves would not secure the desired results, because a vehicle to use such extra width would be compelled to make two departures from its general course. In other words, it would be necessary for the vehicle to swing outward from the tangent, and then after following the curve, to swing back, before resuming travel along the next tangent, thus making a reversed curve. Therefore, it was decided to place extra width on the inside.


50'-0"
50'-0"
Outside Edge
Circular Curve
E.T.C.
PC
P.T.C.
Transition Curve
Circular Curve
Radius
HALF PLAN
SIMPLE CURVE
Transition Curve
PC
P.R.C.
Circular
Radius
PLAN
REVERSED CURVE
Reverse curves should be separated by tangents at least 100 ft in length. Where this is impossible they may be located as shown above. Pavement should be level at P.R.C and superelevation gained in 100 ft in each direction
℄
Outside edge of pavement raised by an amount equal to total superelevation. Pavement straight from there to inside edge
Section at E.T.C.
Typical for all sections on circular curve
Outside edge of pavement raised by an amount equal to ½ total superelevation. Pavement straight from there to inside edge
Section at P.C.
Section at PTC +25
Outside edge of pavement raised by an amount equal to ¼ of total superelevation ¼ Center line at grade.
℄
Section at P.T.C.
Typical section on tangents
Inside edge of pavement around curves will be kept at a uniform distance, equal to crown on tangents, below grade lines

Cross Sections for Determining Warped Surface on Transition Curve.

It was arbitrarily assumed that 8 ft. is the maximum amount of extra width necessary and since 20 degrees is about the maximum rate of curvature used under ordinary conditions in Ohio an extra width of 8 ft. will be used on this degree of curve. Flatter curves will be treated accordingly. Ordinarily it is not practicable to construct transition curves of greater length than 100 ft. and this length is adequate for highway traffic.

Superelevation.—The maximum amount of superelevation used is fixed by the transverse slope satisfactory to horse traffic. The average crown slope on macadam roads in Ohio is one-half inch per foot and since this is not slippery for horses and does not endanger the stability of bulky loads it was decided that this amount used as superelevation would be conservative. This rate of superelevation on four curves will compensate a speed of thirty miles per hour, which is about the average speed on country roads. This same rate of speed was used in calculating the superelevation for flatter curves, while on sharper curves it was assumed that the average driver would decrease his speed to insure safety.

The rate of speed on various degrees of curvature which will be compensated completely by the superelevation adopted is shown in the following table:

Degree of curve.	Equivalent radius of curve feet.	Speed in miles per hour compensated.
1	5,730.0	30.0
2	2,865.0	30.0
3	1,910.0	30.0
4	1,432.5	30.0
5	1,146.0	26.8
6	955.0	24.5
7	818.6	22.7
8	716.3	21.2
9	636.6	20.0
10	573.0	19.0
12½	458.4	17.0
15	382.0	15.5
17½	327.4	14.4
20	286.5	13.5
25	229.2	12.0
30	191.0	11.0

Examples of Superelevation.—In the construction of the National Road through Ohio superelevation was obtained by rotating the standard cross-section around the center line. The results have been reasonably satisfactory, but this method does not encourage the traffic to adhere always to the right side of the road around the outside of curves as by this scheme the rate of superelevation is greater on the inside than on the outside of the curves.

In the present standards a plain section has been adopted. The portion of each transition curve adjacent will necessarily be a warped surface. Cross-sections which will determine this surface are shown in the sketch herewith. On macadam roads this result can be obtained by skilled laborers following the engineer's stakes.

On the rigid types of pavements, which are usually constructed by strikeboards, the desired surface may easily be secured by inserting, perpendicular to the center line, templates cut to the proper cross-sections and then striking off the pavement with a steel bound straight-edge moved parallel to the center line. The distance between these templates should be as great as it is possible to manipulate the straight-edge, which in general will be between 20 and 30 ft.

The increased safety secured by encouraging traffic to follow the right side of the road in all cases will more than justify the slight increased cost of the construction of the transition section of the pavement.

3,512,910 Motor Cars in United States in 1916

The gross total of motor cars, including commercial cars, registered in 1910 was 3,512,916, according to figures compiled by the U. S. Office of Public Roads. This is an increase of 1,067,332 over the number registered in 1915. The several states collected in registration and license fees, including those of chauffeurs and operators, a total gross revenue of $25,865,369. Of this amount 92 per cent, or $23,910,811, was applied directly to construction, improvement, or maintenance of the public roads in 43 states. The figures for 1916 correspond very closely with the annual percentage increase of motor-car registration of the last three years. This yearly increase has averaged 40 per cent in the number of cars and 50 per cent in revenues.

Special Features in Reconstruction of National Road in Ohio

In the reconstruction of the National Road through Ohio, 93 miles of which are now completed or under contract, several features differing from the usual practice in the state were put into effect. These were discribed by Mr. Robert N. Waid, Division Engineer State Highway Department, in a paper presented at the last annual meeting of the Ohio Engineering Society, from which the following notes are taken:

On each side of the pavement an earth drive has been constructed. This is at least 9 ft. wide and can be utilized by horse-drawn vehicles in winter when the pavement is slippery or in the dry parts of summer when a dirt road is more comfortable for such travel than a hard surface pavement. The amount of traffic making use of the dirt berm shows that this feature is greatly appreciated. While this plan might be of questionable value where an entirely new road is being constructed, yet in this instance, where a 30-ft. roadbed was already available, very little additional cost was incurred in providing this convenience.

A variation in the spacing of joints on the concrete sections was employed. Starting from a standard section of 30 ft., the length of the next section was increased to 35 ft. and then, adding 5 ft. at a time, it was increased up to 100 ft. This procedure was repeated five times in succession. Several miles farther on the same thing was repeated. This gives practically two miles of pavement where the length of the sections vary from 30 to 100 ft. Each different length occurs ten times. There is also one section of reinforced concrete, without joints, which is 564 ft. long. As the pavement is only now going through its third winter, it is too soon to draw definite conclusions. To date the extra length of section has not appeared to materially effect longitudinal cracking. Transverse cracks have occurred occasionally in the long sections, but they are not opening up to any great extent. There is a more pronounced spalling at the joints of the long sections, as was to be expected. It does not appear, however, that the difference in this respect will prove serious.

A second feature of the transverse joint is its diagonal direction. Instead of being at right angles to the center line, they are on an angle of 75 degrees. The idea in this arrangement was that no two wheels of a vehicle would hit the joint at one time. By thus decreasing the impact to one-fourth what it would otherwise be, it would seem that the pavement should present a smoother riding surface and the wear at the joints should be greatly reduced. There is no question but that the first of these two objects has been attained, but whether the second will prove of material value can not yet be determined. One disadvantage in this plan has already become apparent. The corners of the pavement, included within the acute angle, have cracked off in numerous places.

The policy of superelevating all curves having a radius less than 1,000 ft. has been followed throughout in the reconstruction of the National Road. The amount of superelevation was computed for a speed of 30 miles per hour, according to the regular manner of elevating railroad curves. The superelevation thus obtained was applied to the entire width of pavement. The maximum amount used is 8 in. and all curves having a radius of less than 500 ft. are given this amount. The center of the road being held at the normal elevation, the pavement was rotated about the center-line, as an axis, in order to produce the superelevation. The inside edge of the pavement was thus depressed as much as the outside edge was raised. The cross section of the pavement underwent no change. Half the amount of depression or elevation was secured each side of the point of tangency, except on curves less than 150 ft. long. On these curves the full amount was acquired on the tangent. Further experiments along this line will doubtless show that the amount of superelevation can well exceed 8 in.

The maximum grade on the roadway between Columbus and Cambridge, with one slight exception, is 7 per cent. Beyond Cambridge the maximum is 7.87 per cent. This is the old 4½ degree grade used when the road was originally constructed. All breaks in grade are connected by vertical curves which vary in length from 100 to 1,600 ft.

Oiled Earth Road, Not 365 Day a Year Road in Iowa

During the past three years many miles of oiled earth road have been in service in Iowa. A personal inspection and examination of all the more important stretches of these roads was made this spring by Prof. T. R. Agg of the Department of Highway Engineering in the Iowa State College, and C. D. Curtiss, Engineer of the State Highway Commission. This trip was made at the time of the spring breakup when road conditions in Iowa are at their worst and during a time which should be most trying for any road surface. The following conclusions based on this inspection are extracted from the April-May issue of the Service Bulletin of the Iowa Highway Commission:

1. Oiling can only be considered as a temporary maintenance.
2. An oiled road must be dragged, but will not require as much dragging as an unoiled road.
3. The lighter oils do not give as lasting effect as the heavier grades.
4. Heavy soils absorb the oil and receive more lasting benefit from the oiling than the light soils.
5. Proper preliminary preparation of the road is essential and of prime importance.
6. Crude tar is not a satisfactory substitute for a good road oil.
7. An oiled road is not a 365 day road.
8. The enthusiasm of the people over the oiled roads indicates their desire for something better.

In general it may be said that the best results were evident where the oil was applied hot. The penetration was deeper; less of the oil remained on the top of the surface and less apparently was carried off the road by the early traffic over it. Depths of penetration were found varying from ½ to 1½ in.

There is one lesson drawn from a study of the sentiment in the localities where oil has been applied and that is that Iowans as a rule are not so much interested in what a good satisfactory dust and mud proof road costs, as they are in getting that road. When a community will pay as high as $300 a year for maintenance expense for a mile of road, for little more can be said for the oiled earth road, and is willing to duplicate the expense the year following for the same conditions, it is sufficient evidence that Iowans want good roads and are willing to pay even high prices to get them.

Method and Cost of Concrete Road Maintenance in Milwaukee County, Wis.

In 1916 about 1,000,000 sq. yd. of road surface was maintained by the Highway Department of Milwaukee County, Wis., at an expense of $5,269.91, which covered all labor materials and machinery depreciation. Of the above yardage, 923,483 sq. yd. was concrete on which $4,051.62 was expended or about .0044 ct. per sq. yd. There was also expended the sum of about $18,000 on shoulder work, ditches, sewers, retaining walls and other miscellaneous items. No part of this sum is chargeable to road surfacing.

Since the advent of road construction work in this county in 1912, the total cost of maintaining concrete road surfaces amounted to $10,721.85. Of this amount $4,822.82 was expended on 43,482 sq. yd. of concrete surfacing which was not built according to modern methods. The yearly maintenance cost of these pavements for the last 3 years is shown in Table I, which is abstracted from the last annual report of Mr. H. J. Kuelling, County Highway Commissioner.

The maintenance methods employed by Milwaukee County on its concrete roads are about as follows: The surface is first swept with a steel broom to loosen any dirt; after this the spot is thoroughly swept with fiber street brooms; to remove the fine dust which the steel brooms leave behind ordinary house brooms are used. These leave the surface in fairly clean condition.

The depression is then covered with hot Tarvia No. 9 and covered with coarse sand or screenings and opened to traffic. In case the depression is of considerable depth or what might be called a hole, one of two methods is employed. First (in case it is desired to avoid delaying traffic), the depression is cleaned, as already described, and then painted with tar, and the whole brought to grade with crushed stone, care being taken not to have the stone as large in size as the depth of the depression. The stone is tamped in place with hand-tampers or rolled with a roller, if one is available, and the voids filled with a heavy bituminous road binder, allowing about 1 gal. per square yard per inch in depth. The second method is to cut the poor place out entirely and after trimming the hole and thoroughly sprinkling sides, fill with the same mixture as was used in the original road. After pouring the concrete the surface is treated the same as in reconstruction.

Small defects due to balls of clay, sticks or coal getting into the aggregate are best repaired in the manner described for shallow depressions. The same is true of battered joints or cracks that may appear.

It is considered economy to have a small maintenance crew who go once or twice each year over all

' YEARLY MAINTENANCE COST OF CONCRETE ROADS IN MILWAUKEE COUNTY, WISCONSIN.

			Concrete maintenance in 1914			Concrete maintenance in 1915			Concrete maintenance in 1916			Total cost			
Year built.	Miles.	Square yards.	Cost.	Cost per mile	Cost per yard.	Cost.	Cost per mile.	Cost per yard.	Cost.	Cost per mile.	Cost per yard	Total cost.	Per mile.	Per yard.	Average yearly cost per mile.
1913.....	21.976	226,777	$1,110.89	$50.55	$0.00489	$556.76	$25.33	$0.00245	$ 940.78	$42.85	$0.00414	$2,608.16	$118.68	$0.0115	$39.56
1914.....	23.845	250,363	446.73	20.35	.00179	613.36	25.72	.00245	833.53	34.95	.00313	1,893.62	79.42	.0075	39.71
1915.....	36.36	400,861	....	......	....	....	......	....	1,121.21	30.83	.00279	1,121.21	30.83	.0027	30.83
1916.....	19.50	203,183	....	......	....	....	......	....	....	......	....	....	....	....	......

the roads in the county. Such a crew consists of a foreman, one team, and four laborers. This crew will, under average conditions, in Milwaukee County, cover all the joints, cracks and small pits in from 1 to 2 miles of 18-ft. road in one day at a cost of from $15 to $30 per mile for labor and materials.

When it is deemed advisable to cover the entire surface, the same method of cleaning is followed, excepting that most of the dirt may be removed with a power sweeper and the tar applied with a power sprayer. After the first treatment of ¼ to ⅓ gal. of tar has been applied, a second may be added in the same manner excepting that an asphalt may be substituted for the tar, as it will adhere to the tar already placed where it will not to the concrete.

Use of Subbase with Concrete Surfaces

An investigation of the use of subbase with concrete surfaces has been conducted recently by the Universal Portland Cement Co., Chicago. Letters were sent to engineers in various parts of the country asking their opinion and practice. In all 86 replies were received. The information requested was as follows: (1) Is the cost of a subbase justifiable? (2) Does its use facilitate drainage? If so, to what degree? (3) Is it of value when used on heavy clay subgrade? If so, what thickness is most desirable? (4) What should be the maximum and minimum thicknesses? (5) What quality and kind of material is preferable? (6) Should the subbase be rolled and tamped? (7) Have any of your observations indicated that a subbase increases or reduces the injurious effects of frost action? (8) Can you point out any advantages or disadvantages not suggested?

A summary of the replies to the questionnaire indicates the following:

Question 1—Consensus of opinion seems to be that the cost of a subbase in general is not justifiable.

Question 2—General opinion seems to be that it facilitates drainage only when proper drains are supplied to carry away the water.

Question 3—The majority seems to think a subbase beneficial on heavy clay subsoils—but many of these engineers are from southern states and claim that in their localities it is unnecessary but that they believe it would be if climatic conditions were more varied, while many of the northern engineers believe it is not only unnecessary but is actually detrimental. However, all agree that whenever used proper side drains are necessary.

Question 4—The minimum and maximum thicknesses seem to be 4-in. and 8-in., respectively.

Question 5—Any porous material seems to be satisfactory: gravel, slag, sand, cinders, crushed stone.

Question 6—The opinion is almost general that when used the subbase should be well compacted.

TABLE I.—SUMMARY OF REPLIES TO QUESTIONS REGARDING USE OF SUBBASE ON CLAY SUBGRADE.

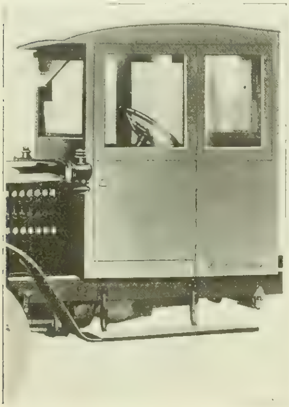
Name.	Is subbase of value when used on heavy clay subgrades? If so, what thickness is most desirable?	What should be the maximum and minimum thicknesses?	What quality and kind of material is preferable?
J. A. Gehres, Akron, O.	6 in. tamped and 4-in. drain tile.	[illegible] in.,tamped.	Screened gravel or slag.
A. Lenderlink, Kalamazoo, Mich.	Yes; 6 in.	6 in.—4 in.	Sand or gravel.
E. E. Spetman, Council Bluffs, Ia.			Cinders or cinders and sand.
J. H. Weatherford, Memphis, Tenn.	Yes.	6 in.	A coarse, loose material, such as crushed stone from 1 to 1¼ in.
L. A. Washington, Paducah, Ky.	No.		Rock or free gravel.
F. L. Ford, New Haven, Conn.	Yes; 6 in.	4 in.—8 in.	Use 1:3:6 pt. cement foundation for their pavements.
E. H. Rogers, Newton, Mass.	Yes; 12 in.	12 in.—6 in.	Cinders, gravel, crushed stone.
J. D. McLeod, Helena, Mont.	Possibly	4 in.—6 in.	Cinders, gravel.
A. G. Brusewitz, Appleton, Wis.	When side drains are provided.	6 in.—8 in.	Pit-run gravel.
Hal Moseley, Dallas, Texas	Questionable.	2 in.—4 in.	Any cheap porous material.
B. E. Briggs, Erie, Pa.	Yes; 6 in	4 in.—8 in.	Broken stone, slag, cinders, gravel, coarse sand.
C. E. Bolling, Richmond, Va.	Yes.		Gravel, cinders.
C. M. Roberts, Chicago	Yes; 1 in.	1 in.—1½ in.	Sand.
H. C. McClure, Toledo, O.	No.		
F. W. Ullius, Jr., E. Milwaukee, Wis.	No.	1½ in. at center and 6 in. at curbs.	Gravel.
W. H. Connell, Philadelphia, Pa.			Cinders.
John Wilson, Duluth, Minn.	No.		Cinders, slag.
Bert C. Wells, Wichita, Kan.	Yes; 3 to 4 in.	3 in.—6 in.	Sand.
R. B. Seawell, Raleigh, N. C.	Yes; 4 to 5 in.	4 in.—6 in.	Cinders.
J. A. Jones, Lewiston, Me.	Yes; 6 in.	4 in.—8 in.	Broken stone.
W. L. Vennari, Lynn, Mass.		Depends on material.	Cinders, coarse gravel.
A. H. Terry, Bridgeport, Conn.	Yes when outlet is provided.	3 in.—6 in.	Sand, gravel, cinders.
J. Kemper, Utica, N. Y.	Yes, 6 to 9 in.	6 in.—12 in.	Field stone overlaid with crusher tailings.
F. H. Anders, Fargo, N. D.	No.		
F. E. Weaver, Hamilton, O.	Yes; 6 to 8 in.	4 in.—8 in.	Bank-run gravel.
J. W. Shields, Altoona, Pa.	Yes; 6 in.	4 in.—8 in.	Screened gravel.
C. Harrison, Everett, Mass.	Yes; 8 to 12 in.	6 in.—12 in.	Cinders, coarse gravel.
B. K. Finch, Wilkesbarre, Pa.	Yes; 6 to 9 in.	6 in.—9 in.	
A. D. Marble, Lawrence, Mass.			Cinders.
C. R. Twiss, Vicksburg, Miss.	6 to 8 in.	6 in.—12 in.	Cinders.
T. P. McCauley, Cedar Rapids, Ia.	Yes; 4 in.	4 in.—6 in.	Sand.
A. W. D. Hall, Jackson, Mich.	6 to 12 in.	6 in.—12 in.	Cinders, gravel.
P. B. Wilson, Marion, Ill.	In special cases, 4 in.	4 in.—6 in.	Gravel, sand, cinders.
A. E. McMahon, Menasha, Wis.	Yes; 4 in.	[illegible] in.—4 in.	Crushed stone.
Benton E. Anderson, Clinton, Ia.	No.	4 in.	Fine Sand.
George W. Cooley, St. Paul, Minn.	Justifiable on heavy clay; 6 in.		Sand, gravel.
T. H. Johnson, Sioux City, Ia.	No, unless as a stiffener.		Anything porous.
W. A. McLean, Ontario, Canada	Yes; 3 in.	3 in.	Cinders, gravel.
C. H. Piepmeier, Springfield, Ill.	No.		
Wm. Kimball, Davenport, Ia.	Yes; 6 in.	6 in.	Cinders.
E. G. Orbet, West Allis, Wis.		3 in.—6 in.	Cinders, gravel.
A. C. Remly, Appleton, Wis.	Yes; 2 to 5 in.	2 in.—5 in.	Cinders.
C. V. Kercle, Janesville, Wis.	No.	2 in.—6 in.	Cinders, coarse sand.
E. F. Harper, East St. Louis, Ill.	Yes; 4 in.	2 in.—4 in.	Gravel.
George Randall, Oshkosh, Wis.	Yes; 2 in.	1¼ in.—2½ in.	Sand, gravel (fine).
J. G. Thorne, Clinton, Ia.	4 to 15 in.	4 in.—15 in.	Sand, gravel, cinders.
B. C. Gowen, Wausau, Wis.	Yes.		Sand and gravel; never cinders.
W. H. Steiner, Marshalltown, Ia.	No.	No.	Sand, cinders.
J. Donahue, Sheboygan, Wis.	Yes.	3 in.—6 in.	Cinders.
W. M. Atchinson, Syracuse, N. Y.	Yes.	6 in.	Gravel, stone.
E. B. Parsons, Milwaukee, Wis.	Yes; 4 in.	4 in.—6 in.	Cinders, gravel.
A. D. Williams, Morgantown, W. Va.	Yes, under certain conditions.		Broken stone.
J. G. Gableman, Chicago	Not unless proper drainage is provided.	6 in.—8 in.	Broken stone.
F. C. Lohman, Champaign, Ill.	Yes; 3 in.	[illegible] in.—6 in.	Gravel.
H. B. Overesch, Lafayette, Ind.	Yes; 6 to 8 in.	4 in.—8 in.	Gravel, cinders.
Roscoe N. Clark, Hartford, Conn.	Essential; 12 in.	6 in.—12 in.	Crushed rock, gravel, sand, cinders.
F. LeCocq, Aberdeen, S. D.	2 to 6 in.	2 in.—6 in.	Cinders.

Question 7—Many seem to think that the injurious effects of frost action are increased by the use of a subbase, though the majority claim such action is reduced provided the subbase has proper side drains.

Question 8—Several points brought out are: Make work possible on clay subgrade in wet weather. That it is a detriment in that it absorbs water from the green concrete.

A summary of replies to questions 3, 4 and 5 is given in Table I.

"All Year" Cab for Motor Trucks



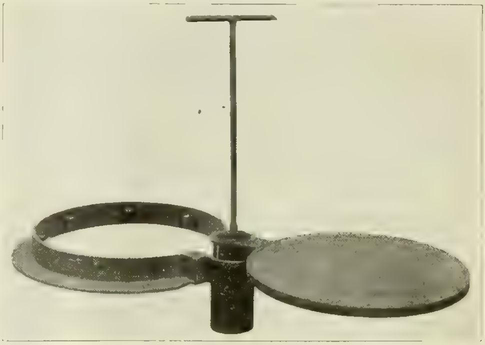
An innovation that is destined to have a marked effect on the efficiency and comfort of motor truck drivers and one that will give increased results to truck owners is that of the all year cab, originated, designed and built by the Kissel Motor Car Co., Hartford, Wis. This is a new adaptation of Kissel's original convertible idea, giving to truck drivers a closed cab, which can be easily and quickly changed into the Kissel standard open cab in summer.

Standing a little over 5 ft. from chassis frame to roof, the cab frame is of extra hard wood, bolted and locked. All sides and doors are covered with specially treated sheet metal, enabling the cab to withstand the twists of the frame when negotiating rough roads. The dash is of heavy plated metal, giving unusual substantiality.

The all year cab, which is exclusive with the new Kissel trucks, is in its open form, without the winter inclosures, standard equipment on all the new Kissel truck models excepting "The Flyer" light delivery car. The winter inclosures for the all year cab cost $50 extra.

Sidewalk Receptacle for Street Cans

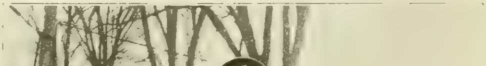
A useful type of sidewalk receptacle for the cans employed by the street cleaning department for street sweepings and refuse has been adopted by the cities of Springfield and Worcester, Mass. An excavation about 3 ft. in diameter and about 5 ft. in depth is made just inside the curb, in the sidewalk or tree belt. The bottom is filled to the depth of about 2½ ft. with crushed rock, to allow for drainage, and a 24-in. 2-ft. length of sewer pipe is placed bell end down upon the crushed rock. A pivot lock cover is then placed on top of the sewer pipe. The excavation around the sewer pipe is filled with dirt and packed to within about a foot of the surface and the remainder of the surface is set in concrete, leaving the cover flush with the sidewalk. The principal feature of this installation is the cover. This device consists of a locking and operating mechanism, the working parts of which are simple, compact and only three in number. The parts are incased in a moisture and dirt-proof housing attached to the frame and floated in grease. The mechanism is operated by a key wrench having a T-handle about 3 ft. high, the lifting power being applied from the under side of the cover. The device is known as the "Rausehousen Pivot Lock Cover." It is being placed on the market by East Iron & Machine Co., Lima, O.



Pivot Lock Cover for Sidewalk Receptacles.

A Cast Iron Guide Board with Removable Letters

A highway guide board of especially useful design is being employed along the Lincoln Highway and in certain sections of New England. The post is cast iron and is imbedded in concrete below the frost line.



The Leb-Iron Guide Board.

The directions on the board are in heavy raised letters with a baked enamel finish. The board is so built that the letters can be removed, which makes it possible to replace any damaged symbols. This guide board is known as the Leb-Iron. It is manufactured by the Lebanon Machine Co., Lebanon, N. H.

Waterworks and Hydraulic Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* W. H. FOGERTY, *General Manager.*

First Wednesday Each Month..............Roads and Streets...$1 Yearly
Second Wednesday Each Month....Waterworks and Hydraulics...$1 Yearly
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Volume XLVII. CHICAGO, ILL., JULY 11, 1917. Number 2.

How City Waterworks Can Profitably Be Used for Irrigation Purposes

In order to indicate somewhat specifically how a city waterworks can profitably sell water for garden irrigation, we shall assume conditions that prevail in many a city of 8,000 to 20,000 people.

The investment in the plant is, say, $40 per capita, of which $12 is prorated to fire protection, based on the "peak load" or maximum demand for fire, and not on the quantity of water used. This leaves a $28 investment per capita for residential and other service. Again prorating on the basis of peak load requirements, we have, say $20 per capita for residential service only. With 5 members in the average household this gives $100 investment per household. Let interest, depreciation and repairs be 9 per cent, or $9 per year per household. Then the fixed and minimum plant charge becomes 75 ct. per household per month, whether any water is used or not.

Let the cost of fuel and labor at the pumping station be 2 ct. per 1,000 gal. when only 75 gal. per capita are pumped daily. This pumping cost would then be 22 cts. a month for a household of 5 people using about 11,000 gal. a month. Liquid chlorine for this amount would cost about 0.05 ct. per 1,000 gal. or about 0.5 ct. a month. This makes a total monthly cost of 97.5 cts. exclusive of metering. The monthly interest, depreciation, repairs, reading and billing cost, say, 20 cts. per meter, which, added to 97.5 cts., is $1.175, exclusive of general expense, as the monthly cost per household service with a consumption of about 11,000 gal. a month.

Let the base rate, then, be $1.25 a month per household service, with no further charge unless the water consumption exceeds 10,000 gal. per service. Then let the charge decrease very rapidly for all water used in excess of 10,000 gal., thus:

	Per 1,000 gal.
First 5,000 gal. excess	6 ct.
Second 5,000 gal.	5 ct.
All over 20,000 gal.	4 ct.

In the arid regions of the west it has been found that 3 acre-feet of water per season are ample for irrigating nearly every kind of crop. An acre-foot (1 ft. deep over an acre) is about 325,000 gals. Hence an acre-foot of water at 4 cts. per 1,000 gals., costs $13. An acre-foot of water in addition to the normal rainfall is ample for a season's irrigation in the humid parts of America, such as the northern-central and the eastern states.

It is obvious that several times 4 cts. per 1,000 gals. can profitably be paid for water with which to irrigate "garden truck" in the humid parts of America, for the value of the garden crops often runs as high as $1,000 an acre per season. Where additional wells and reservoirs are needed to supply the increased demand for water for irrigation, the charge for water for city irrigation must be increased, but an existing plant will suffice in most cities, for years to come, provided the present water waste is reduced by metering.

If for each city the costs are analyzed as above indicated, and there is put into effect a scientific schedule of rates based on metering the supply, there will be few if any cities that will not find it profitable to sell water at very low rates for irrigating back yards, vacant lots, and suburban gardens.

We tacitly assume that on the real estate of the city there should be levied a tax to pay an adequate hydrant rental for fire protection. From one-quarter to one-half the annual interest and depreciation charges on a waterworks plant should ordinarily be assessed against fire protection. Except skilled hydraulic and rate-making engineers, there are few men who realize that the peak load on a water plant, due to the great, though brief, demand for water at time of a conflagration, is such as to make equitable a very large charge for fire protection.

If every city would employ a skilled hydraulic engineer to plan its rate schedules, and would follow his advice, there is not the slightest doubt that water now wasted would be diverted to the irrigation of gardens. Direct profit to water plants would result, but the profit to the community would be manifold greater through the increased production of vegetables and fruits.

Two Thousand Dollar Income from an Irrigated Acre in Bridgeton, N. J.

In our last Waterworks and Hydraulic Monthly issue, we gave some striking instances of the profits derived by owners of small tracts of land in the city of Bridgeton, N. J., as a result of irrigation. The city supplies water for 32 small irrigating plants of less than an acre each, the water being delivered to the crops from overhead pipes.

Mr. John S. Ware last year sold $2,100 worth of produce from 1⅛ acres, and netted a profit of more than $700 after paying for all labor. The detail figures are given in our June 13 issue.

Mr. John P. Marts last year made a profit of $2,000 from one acre, not counting the value of his own time. This year he is cultivating three acres and expects to clear $5,000. Two years ago he was a glassblower, and when the factory closed, he turned to farming on a small scale. He eked out a living from an acre the first year, but the next year his net income was $2,000. His principal product is lettuce, and he raises a spring and a fall crop totaling 63,000 heads from an acre. His success is attributable to irrigation.

Mr. Ware, for his 1⅛ acres, paid the city $30 for water in 1916. The city charges at the rate of 2 cts. a year per foot of overhead sprinkling pipe, which indicates that he had 1,500 ft. of pipe, or less than 1,340 ft. per acre. (See our issues of Jan. 10 and Feb. 14 for methods and cost of constructing and operating overhead or spray irrigating systems and the amount of water required.)

The U. S. Dept. of Agriculture states that with the spray system of irrigation, truck gardeners in humid districts ordinarily use only ½ acre-foot of water per season, or 160,000 gals. per acre. Sandy soil requires more water than clayey soil. If Mr. Ware used an acre-foot, he paid about 10 cts. per 1,000 gals. for water during 1916. Note, however, that the value of his crop was 70 times the price paid for the water. Is it to be wondered that a truck gardener is willing to pay liberally for water under such conditions?

The present high prices of vegetables yield higher profits than can normally be expected, but results such as those above cited make it very clear that nearly every water works superintendent has been "asleep at the switch." The U. S. Dept. of Agriculture estimates that there are 2,000,000 backyard gardens that have come into existence as a result of the war and the publicity given by newspapers. Probably many of these gardens will be failures, for one or another reason. Let water works superintendents and engineers teach the public how to irrigate and manage such gardens, and there will be relatively few failures next year.

With the water bills that are mailed there should be enclosed a pamphlet on garden irrigation and advice on the raising of different kinds of vegetables. The Department of Agriculture will furnish you bulletins that can be abstracted for this purpose. Start your publicity campaign this winter and make up your mind thereby to increase your sales of water next spring. For every dollar that you add to the income of the waterworks plant there will be fully ten added to the profits of those who use the water for garden irrigation.

Does Liquid Chlorine Provide Complete Protection Against Typhoid?

In our last Waterworks and Hydraulic Monthly issue we published letters from two of our readers questioning the accuracy of an editorial in a previous issue wherein we had said that an expenditure of 2 cts. per capita per annum for liquid chlorine insures immunity from typhoid fever. Our readers did not question the efficacy of liquid chlorine nor its low cost per capita, but they pointed out that typhoid is not always conveyed through the water supply. Typhoid among our soldiers in the Spanish war was cited as an example of the spread of the disease through the agency of flies.

Of course we were aware of the fact that flies and other carriers may spread the germs of typhoid, and that milk and other foods are occasionally contaminated; but the total effect of all such causes of typhoid in cities is infinitesimal compared with the number of typhoid cases directly traceable to contaminated water. This is strikingly apparent when the death rate from typhoid before treatment of water is compared with that subsequent thereto.

In a city that is sewered the effect of flies as carriers of typhoid is practically nil. In camps and in unsewered places the danger from flies is great. This leaves only three important sources of typhoid fever in cities—the water, the milk, and human "carriers." Some persons carry the germs of typhoid in their systems indefinitely, and spread the disease to others by infecting the food that they handle. Such "carriers" are relatively rare, and obviously would become almost non-existent if the primary source of infection—the water supply—were purified. Due to the action of state boards of health, the danger of infection from milk is already small and is steadily decreasing. If all farm water used in washing milk cans were treated with liquid chlorine, typhoid danger from milk would be eliminated.

While it was not our intention to criticise the efficacy of typhoid vaccination, we regard it as unnecessary for people living constantly in cities where the water is properly treated. Furthermore we believe it can be made unnecessary for all Americans, other than those living in camps or where it is impracticable to protect all excreta from flies. Certainly it is feasible to treat water in the smallest town, and even on the farm, with liquid chlorine. The cost is nominal and the insurance against typhoid is purchased at less cost, to say nothing of reduced inconvenience, than by vaccination.

Economy of Small Earth Reservoirs as Adjuncts to Pumping Plants for Irrigation

Whether electricity, gasoline or steam is the motive power in pumping for irrigation, it will usually be found economic to provide a reservoir even where the plant is small. In California, where electric power from central stations is largely used by farmers, it was soon discovered by the farmers that it pays them to keep down the size of their motors, for electric rates involve a minimum monthly charge per horsepower of installed capacity plus a kilowatt hour rate. A 5 H. P. electric motor driving a small pump continuously—as it may if there is a reservoir—is far more economical than a 50 H. P. motor that works intermittently to supply the water as it is needed.

While this fact is clearly apparent when electricity is purchased on a scientific rate schedule, it is not as apparent when an irrigator develops his own power. Nevertheless it can be readily demonstrated that even where gasoline or distillate engines are used it ordinarily pays better to have a small engine that pumps continuously into a reservoir than to have a large engine that pumps directly into the field.

In our last Waterworks and Hydraulic Monthly, p. 531, we gave some very interesting data relative to the construction and cost of small earth reservoirs, holding 125,000 to 750,000 gals. and costing only $125 to $350. One of these earth reservoirs holding 500,000 gal., was built in 1916 for $350, and furnishes water for 110 acres, making the reservoir cost but little more than $3 an acre. A 25 H. P. Westinghouse motor, driving a 4-in. Byron Jackson pump, furnished the water, so that the power is less than ¼ H. P. per acre.

In another instance, a cement lined reservoir holding 125,000 gal. and costing $380, irrigates 27 acres, making the cost of reservoir nearly $15 per acre. Here a 5 H. P. motor and 2-in. horizontal pump is used, or less than 0.2 H. P. acre. The annual expense of irrigating these 27 acres is $250, or less than $10 per acre.

There are 45 of these small reservoirs in the territory served by the Southern Sierras Power Co., of Riverside, Calif., which were built within the past two years.

The Opportunity for Civil Engineers as Waterworks Superintendents

The rapid spread of the "city manager" form of municipal government indicates very clearly that the American public is heartily sick of the time-honored —or rather time-dishonored—methods of city administration. And with the advent of "city managers," selected by a commission instead of by election, has come the management engineer as a great factor in city affairs. This movement will continue to spread, and it is to the interest of civil engineers to promote its spread, not only from city to city but throughout all the technical departments of every city.

A water department is, or should be, a technical department, and the head of such a department should be technically trained. By this we do not mean that he should necessarily be a graduate of a technical school, but we do mean that he should at least be self-educated in matters that pertain to the economic operation of a waterworks plant. In a word, every waterworks superintendent should be a student of what other superintendents have done and are doing to better the water service to the community and coincidentally to increase the economy.

Perhaps one waterworks superintendent in three is more or less of a student of waterworks problems. The rest simply "fill" their positions very much as a knot fills a knot hole, because it happens to be there. Now, the "let well enough alone," salary-sucking sort of a superintendent is not going to be typical many years longer. For one, this journal purposes conducting a campaign to assist in the extermination of that type of city officials.

In many instances the present superintendents of waterworks are of the kind that never will wake up and change their mode of action, or rather inaction. They are the ones that civil engineers should seek to displace. On the other hand, there are many superintendents who will be aroused by the increasing public demand for more effective service by public servants, and those superintendents stand an excellent chance to "make good." There is nothing so deeply technical about the management of the average waterworks that a man may not educate himself to be an efficient superintendent, provided he has the ability and desire to learn. But here, as in every position of a technical nature, the process of learning should never cease. Not a month passes that we do not publish new information that will increase the efficiency of a waterworks manager, if he will only study it and consider its applicability to his own problems.

The Need of Irrigation in the Humid States

Where the rainfall exceeds, say, 20 in. annually it is customary to speak of the climate as "humid." It has also been the custom to regard irrigation as being unnecessary in "humid" districts, but within the last ten years there has been a slow awakening to recognition of the fact that even where irrigation may not be "necessary" it may be decidedly economic.

The growing season in our northern states is 6 months long, and it is during this season that the crops must have water in abundance and almost continuously. For the best results there should not be a spell of longer than about two weeks without at least an inch of rainfall, and during this six-month period (Apr.-Sept.) fully 18 in., or 1½ acre-feet of water are needed. While there is usually a sufficient total of rainfall, say 18 in., during the growing season, there is rarely a season when most of the crops do not fail to get the needed one-inch of rain during some stretch of two weeks.

A few years ago Mr. Milo B. Williams, Engineer of the U. S. Dept. of Agriculture, in charge of irrigation investigations in humid regions, showed that during a period of 10 years there were many days a year when insufficient rain fell in the growing season. The following is the average number of days when irrigation was needed during the growing season in 5 different "humid" localities:

	Days.
Iowa (Ames)	19
Wisconsin (Oshkosh)	29
New Jersey (Vineland)	35
South Carolina (Columbia)	57
Alabama (Selma)	72

Yet in none of these places was the average annual rainfall less than 30 in. (See Engineering and Contracting, Aug. 28, 1912.)

Civil engineers scarcely realize the truly tremendous amount of irrigation work that awaits their initiative in this country. There is not a state in the Union, from water-logged Florida to arid Arizona, that does not need irrigation this very summer.

Pumping plants, reservoirs and pipe lines without number are economic necessities. Yet most of us civil engineers complain that there are too many engineers in proportion to the available positions! What we have lacked is imagination and initiative. There is work enough to keep every American civil engineer busy for ten years to come putting water onto "humid" farms whose humidity many times every year fails to be ample at the right time.

The air in water is undoubtedly one of the causes of the rusting of water pipe. Mr. H. R. Holmes, an engineer of Pensacola, Fla., proved that an excessive amount of air in the water was the cause of an unusual rapidity of corrosion of pipes. The corrosion was so rapid that it had been attributed to electrolysis, but Mr. Holmes not only showed that no appreciable electric currents existed but that the corrosion of the pipes was mostly on the inside and at the top where air bubbles were liberated. Water drawn from a faucet into a glass liberated bubbles of air in abundance.

There are 450 irrigation companies in California, and it is estimated that they will irrigate a million more acres in 1917 than in 1916.

Costs of Preparing Valuations for Small Water Companies

By ALLEN F. BREWER, JR.

Mem. A. S. M. E. Assistant Engineer, Valuation Department, Public Utility Commission of New Jersey

Under present day methods of valuation and appraisal, among the many important questions which are constantly arising is that of the actual monetary expense entailed in performing a valuation of any particular type of property. From time to time well known engineers have come forth with statements of costs to inventory and appraise a certain public utility or industrial corporation, derived from personal experience and expenses. Elaborate tables of detailed expenses and methods pursued are nearly always a part of such papers, together with complete descriptions of conditions met with, and conclusions drawn. Such data, it is of course granted, are of inestimable value to the engineering profession and particularly to those who have to deal with valuation work of any magnitude.

It is an unfortunate fact, however, that the engineer-authors seem to dwell in particular on data relative only to valuations of considerable magnitude. This may probably be explained by stating that in almost every instance the average consulting engineer who specializes in valuation work deals primarily with corporations of million dollar capitalizations or over. As well, his work will cover a wide field and afford little or no opportunity for comparison of costs entailed or methods pursued. For example, a certain eminent firm of engineers deals primarily with valuation work in the interests of banking houses which intend to underwrite issues of securities. Such valuations are many, but cover every conceivable type of industrial or public utility corporation. Therefore, can fair comparisons result? Can the costs of valuations of gas companies be compared with those for electric or manufacturing companies?

It is with the smaller types of corporations that valuation cost data are particularly needful, and where they have seemed to be most neglected. Here let us consider, for a moment, the several purposes for which valuations are undertaken. They are: For taxation purposes; for rate regulation; for issue of securities; for determination of total capitalization; for sale or transfer of property; and for establishing uniform systems of accounts.

By study of the above it is thus seen how frequently it may be necessary for a corporation to undertake a valuation of its physical properties. Of course, if our corporation in question be a public utility, should any of the above cases arise, in nearly all states where state control of public utilities is enforced, the valuation will be carried out by the valuation department of the Public Utility Commission. But the industrials must still take care of themselves or employ consulting engineers to perform the work. Yet, as great accuracy is not required in the valuation of an industrial or manufacturing plant, as in that of a public utility, since that all-important point of discussion, "Rate Regulation," is never pertinent.

The rates affixed by a manufacturing corporation to its products are governed by conditions and needs of the local, national or world markets. The public utility, however, cannot raise its rates as it sees fit. Should it deem this to be essential it must petition to the State Public Utility Commission in nearly all instances. Such a petition will entail valuation by the Commission's staff of engineers before a decision can be handed down in the case.

Inasmuch as the author's experience has been chiefly with valuation of public utilities, of course it is along such lines that this article has to deal, and in particular with water companies. Many times in connection with his professional work he has been questioned by officials of smaller-sized utilities as to the approximate cost of an inventory and appraisal of their properties. As a result he has compiled cost data of a number of recent valuations of water companies located in New Jersey, upon which he has worked.

It is frequently the desire of such corporations, as of course all other types, to ascertain approximately the reproduction or present value of their physical properties, with a view to installing additions or betterments, or putting forth new issues of securities. They do not care, however, to take up the matter with their State Public Utility Commission unless they are reasonably sure that they have ground on which to base their contentions. It is usually their belief that engaging professional engineers to perform such a valuation will entail expense beyond their means; hence, unless their proposed betterments are really demanded they will oftentimes abandon the idea. If they do ultimately apply to the Commission for an inventory and appraisal perhaps they will be compelled to wait months for such to be carried out, due to work preceding theirs before the valuation department of the Commission.

Thus, the patrons of the particular utility suffer in the meantime. On the other hand, if the officials of our particular utility could form an approximate idea of the cost of their valuation and did engage valuation experts to carry out their work, they would be aiding their State Commission inestimably, and, as well, would begin to reap the additional revenue from their betterments far sooner. In such a case the valuation engineers employed by the Commission could check up the inventory and appraisal set before them in probably one-tenth the time that it would take to do the actual work themselves, and immediately turn it over to the Commission for discussion and decision. Therefore, the accompanying cost data is offered in the hope that it may encourage officials of smaller water companies who believe that a valuation means a huge expense. In order to avoid breach of confidence it has been deemed best not to state the names of the corporations to which this data applies. They are, therefore, designated by number both in the table and on the chart.

The cost of making a valuation will be governed entirely by conditions local to the corporation under consideration. Most important will be the condition of the books, records and vouchers at the time of valuation. If these have been kept completely and efficiently year by year it will be a simple matter for the valuation engineer to ascertain original costs of all improvements, additions or extensions. On the other hand, if the records are incomplete and the vouchers destroyed it will be necessary to estimate cost data from previous experience with similar cases, or to make studies covering a reasonable period of time in order to obtain fair averages. This, of course, will take more time on the part of the engineer and will be less accurate by far than if he had been able to note costs in detail from the records of work orders or authorizations. Another item which will have bearing on the final valuation cost is the amount of field work necessary. Traveling expenses, hotel bills and incidental expenses mount at an alarming rate, therefore the officials of the corporation should make every effort to aid the engineers in such matters as locating distribution mains on a proper map, scaling lengths of same, listing equipment, measuring structures and many other items.

Actual inventory can very often be most efficiently performed by employes who have to do with certain departments in their daily work. For instance, water meters might be far easier inventoried by an expert meter man than by a professional appraiser. It is granted that the engineer will know more than the meter man, but the latter is certainly as capable of listing his meters by size, make and type, as is a high salaried expert. If the company prepares such an inventory covering its entire property, listed under the proper accounts it will be a simple matter for the engineer or appraiser to make a cursory check of this, and promptly proceed to the more exacting task of pricing the same.

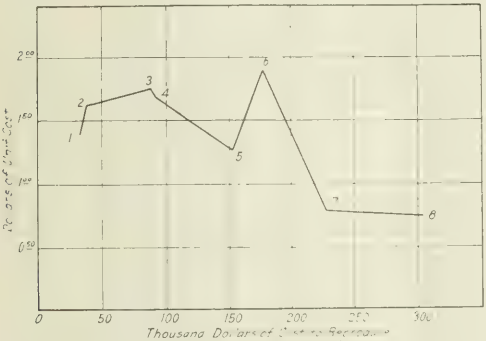


Chart Showing Fluctuation of Unit Valuation Costs per $1,000 of Cost to Reproduce for Water Companies.

It is interesting to note the effect of such assistance on the part of the various water companies to the appraisal engineers, in the accompanying cost figures, Table 1. In the cases of Companies No. 7 and No. 8 the officials used every means at hand to facilitate the work of appraisal. Records were particularly well kept, and employes aided the engineers in making their field inventories and summarizing the same. In the case of Companies No. 1 and No. 5 material assistance was afforded by the officials, but much of the detail of the inventory work was performed by the engineers, inasmuch as the records were not in as good condition as they should have been. Considering the four remaining examples, Companies No. 2, 3, 4 and 6, we see here typical cases of water company valuation, where practically all the field work was done by the valuation engineers. This is by far the most common condition that will be met with in carrying out valuations of moderate-sized public utilities. Their employes are few, and in general poorly paid and overworked. Hence the engineers should not expect much if any assistance in making their inventory, unless it is possible to persuade the gang foreman or meter man to work overtime in listing tools, meters, hydrants, valves or mains.

TABLE I

Company No.	Cost to reproduce	Total cost of inventory, appraisal, and preparing report.	Unit cost per $1,000.
1	$ 32,280	$ 45	$1.39
2	39,038	63	1.62
3	88,690	157	1.77
4	91,823	155	1.69
5	153,912	197	1.28
6	178,548	337	1.89
7	228,173	181	.79
8	307,248	228	.74

The chart shows the curve resulting from plotting the unit costs and costs to reproduce tabulated in Table 1. It will be seen that these figures are fairly representative of conditions existing in water companies today, under or near a capitalization of $300,000, and the costs of valuation are easily within reason, considering the field conditions met with by the valuation engineers. As well, we must bear in mind that the above costs have been in part governed by the purpose for which each appraisal was made, i. e., an appraisal to be used as a basis for fixing of rates would naturally be made more carefully than one to check up a security issue or to form a basis for opening new accounts. In Table 1, Company No. 6 was the only case involving a rate discussion, and, as might be expected, its unit cost is the highest. The other examples were all made for the purpose of reorganizations or bond issues, both of which purposes require equal care in the performance of the valuation work.

In conclusion, therefore, it seems fair to state that the accompanying unit costs as quoted may be safely used by either engineers or water company officials in obtaining a reasonable idea of what a proposed valuation would cost, provided they know the approximate reproduction cost of the company in question, the purpose of which the valuation is to be made and the extent to which they can use cheap labor in making the actual field inventory.

As a closure it is interesting to note the statement made by Henry Floy, A. B., M. A., M. E., in his Valuation of Public Utility Properties, page 52: " . . . Where there are many structures of various types, . . . many and varied elements, making the compilation of the inventory and the determination of the unit prices an arduous and time consuming task, the expense of the appraisal work may run up to a dollar or more per thousand dollars of property valued. . . ."

Artesian Water in Arid Arizona Valley

A careful and thorough study of the artesian and other ground waters of the San Simon Valley in southeastern Arizona has recently been completed by the United States Geological Survey and the Arizona Agricultural Experiment Station. The total number of flowing wells in the vicinity of San Simon in 1915 was 127. The flow of these wells ranged from less than a gallon to about 300 gal. a minute, and the average flow from 116 wells measured in 1915 was 52 gal. a minute. The combined yield of the 127 wells, if they flowed continuously, would be about 15 second-feet, or 6,700 gal. a minute. Comparison of the flows of 12 wells measured in 1913 and 1915 shows that in two years the aggregate yield of these wells decreased 45 per cent and that individual wells showed decreases in flow ranging from 20 to 80 per cent. This decrease is attributed largely to the filling of the uncased wells with sand and the caving of the walls of these wells, but in part to the depletion of the artesian supply. The Government geologists regard it of the utmost importance to the future welfare of the valley that all wells be properly cased to the bottom with heavy casing and fitted with valves, which should be closed when the water is not needed.

50,000,000 Gal. Activated Sludge Plant Recommended for Stockyards District Chicago

As a result of an extended investigation conducted by Mr. Langdon Pearse, representing the Sanitary District of Chicago, and Mr. W. D. Richardson, representing plants in the Union Stockyards, the conclusion has been reached that the activated sludge process offers the best promise of a solution of the sewage problem of the stockyards district of Chicago. In their report, made public recently, Messrs. Pearse and Richardson, present preliminary estimates on the cost of installing, maintaining and operating a plant of 50,000,000-gal. capacity, that would produce a stable effluent that could be discharged in the channel of the Sanitary District. They recommend, however, that a working unit be constructed at once and operated for at least 6 months before the definite building program is decided upon. Extracts from their report are reprinted below.

In addition to the activated sludge process, devices should be installed to catch the grit, retain grease and screen out coarser solids arriving at the plant prior to the activated sludge treatment. Such community screens are required in addition to the individual screens recommended on paunch manure outlets.

Grit Chamber.—The sewage brought to the plant should be carried through a grit chamber with a minimum velocity of 1 ft. per second, to settle out any mineral matter arriving at time of storm. Part of the grit chamber may serve as well for grease skimming on the surface. The grit chamber should be built in several compartments to provide ready cleaning. The flow length has been made approximately 100 ft.

The amount of grit retained is very uncertain. The results of the testing station shows 0.02 cu. yd. per 1,000,000 gal. Probably this would be exceeded.

Screens.—Coarse bar screens should be provided, followed by fine screens. The coarse bar screens should have a clear opening of about 1 in. Should pumps be used, the screens should be set ahead of the pumps. The fine screens should be self-cleaning, of a mesh from 20 to 30 per inch or else equivalent narrow slots. The results at the Sanitary District testing station indicate that 600 to 1,000 lb. of dry material may be recovered per 1,000,000 gal. of the day flow of sewage. This material has a moisture content of 80 per cent. The typical analysis follows:

	DRY BASIS PER CENT.			
	Fixed.	Volatile.	Nitrogen.	Ether sol.
Screenings	5	95	2.18	9.4

Inspection of this material shows that it is largely paunch manure, fibre, fleshings, guts, etc., all material slow to activate and troublesome in the tanks. The value of this material as a fertilizer is scarcely higher than barnyard manure.

Grease Skimming.—Although the surface of the grit chamber will undoubtedly remove a considerable amount of grease bearing scum, additional facilities will probably be required. With a flow of 105,000 to 150,000 gal. per 24-hours, a surface area of 10.25 sq. ft. produced a removal of 5 to 1,260 lb. of scum per 1,000,000 gal. with an average moisture content of 75.6 per cent and an ether soluble content on a dry basis of 65.6 per cent. The removal of ether soluble material varied from 2.5 to 630 lb. per 1,000,000 gal.

In addition, considerable data (Table I) has been acquired from the actual grease skimming basins operated by the packers at the outlet of Ashland Ave. and Center Ave. sewers. The area of the basins has averaged 3,196 sq. ft. at Center Ave. and about 1,200 sq. ft. at Ashland Ave., with a supplementary river area at Center Ave. of 9,000 sq. ft.

With a total area of 13,396 sq. ft., therefore approximately 8,000 lb. of scum have been caught daily. Of this, roughly 3,600 lb. may be ether soluble.

The indications are that an area of 3,000 to 4,000 sq. ft. should be provided for grease skimming, with low surface velocities and high bottom velocities. This would be ahead of the activation tanks. The grease skimming tank should be arranged to drain, so deposits could be cleaned out. For a tryout the grit chamber can be utilized, built to permit the addition of more area if needed.

Roughly speaking, from the new plant the amount of grease collected should be over 1,000 lb. per day, or over 3,600 lb. ether soluble material. The average collection the year around at the testing station showed 360 lb. scum per 1,000,000 gal. or over 47 lb. grease per 1,000,000 gal., assuming 20 per cent of the ether soluble matter recoverable as grease. Based on an average flow per 24 hours of 30,000,000 gal. the grease would be 1,410 lb.

Aeration Tanks.—In accordance with results obtained at the Sanitary District testing station on the Center Ave. sewage, the estimates have been made for a plant to produce complete stability in warm weather on the following assumptions:

1. The aeration of the screened sewage in continuous flow tanks using 4 cu. ft. of air per gallon of sewage, with an 8-hour contact period of sewage and activated sludge.
2. Sufficient sludge storage capacity in the aeration tanks to care for 140 per cent of the sewage entering the tanks. Approximately 40 per cent of the incoming flow is returned from the settling tanks, as a mixture of sludge and sewage.
3. The depth of the tanks has been fixed at 16.5 ft. over the plates. The air distribution proposed is through filtros plates set in unit boxes of cast iron. The ratio of the area of filtros plates to the superficial area of the tank is about 1 to 6; 1,080 sq. ft. of plate area are provided for each unit, of 1,500,000 gal. daily, or 720 sq. ft. per 1,000,000 gal. daily.

In the design suggested, 32 units are proposed, each of 1,500,000 gal. daily capacity. Each unit is 38 ft. 4 in. wide by 160 ft. long, with 16.5 ft. water depth over the plates. The tank is divided by wooden baffles into 3 longitudinal channels in series. A covered pipe gallery is planned between the batteries of tanks, in which the air and sewage mains can be carried. Individual air and sewage meters are included in each unit, in addition to the two large meters, which handle the entire flow of air and of sewage.

Pipe Gallery.—The design contemplates putting the main distribution pipes for sewage and air in a cov-

TABLE I. ESTIMATED RECOVERY OF GREASE FROM PACKINGTOWN SEWER OUTLETS.

Location.	Scum.† Lb. per day gross.	Ether sol.	Actual grease extracted. Lb. per day.
Center Avenue:			
Armour	2,800	1,260	333*
Morris	750	340	67*
Fitzpatrick	2,600	1,170	200*
Ashland Avenue:			
Morris	1,780		240‡
Total	7,930		840

†Observations made by Sanitary District March 8 to 27, 1915.
*Data from Armour & Co. as of December, 1916.
‡Data from Morris & Co. as of February 28 to March 29, 1916.

ered pipe gallery, between the rows of aeration tanks. This gallery will also contain the individual meters for air and sewage for each tank. The design can also be adjusted to pass the smaller air pipes under water to the pipes connecting with the filtros plate boxes.

Settling Tanks.—After thorough agitation in the aeration tanks, the liquid passes to settling tanks, in which the sludge is settled out. The settling tanks proposed are of the circular Dortmund type, 30 ft. internal diameter, with a water depth of 33.5 ft. The hopper bottoms have a slope of about 60° with the horizontal. The settling period is about 1 hour. The Sanitary District has been operating such a tank with a period of 40 minutes, the normal vertical velocity being 10.4 ft. per hour.

Air Supply.—Where filtros plates are used for air distribution, experience shows that clean air is desirable, in order to avoid the clogging of the under surface. Oil, soot, particles of dust and other foreign material should be removed. Therefore, air washers preliminary to the compressors have been included in the estimates.

TABLE II.—PRESSING SLUDGE: COST OF SUPPLIES, ETC., PER DAY, BASED ON 96 TONS OF DRY MATERIAL.

Supplies:			
75 lin. yd. 120 in. wide No. 8 duck @ $1.75 per lin yd.		$132.00	
Oil, waste, etc.—			
2 gal. oil @ 50c	$1.00		
5 lb. waste @ 10c	.50		
		1.50	
Lamp renewals		.50	
Repairs and renewals—			
Racks, 1 daily at	$10.00		
Packing	.50		
		10.50	
Contingencies		10.50	
			$155.00
Labor:			
Foremen—½ time @ $3,600 per 1/300 year		$ 6.00	
Laborers—1/300 of $31,140		103.00	
			109.00
Power:			
Lighting		21 H. P.	
Pumps		250 H. P.	
Conveyor		40 H. P.	
		311 H. P.	
311 H. P. = 232 K. W. Hr. @ $0.007 per hr. for 24 hrs. =			39.10
Interest:			
Interest on *$752,600 @ 5% =	$37,630		
Depreciation on 615,200 @ 5% =	30,760		
137,400 @ 4% =	5,496		
	$73,886 ÷ 1/300 =		246.29
Total			$549.39
Estimated cost per dry ton			5.72

*This figure represents the cost of presses, foundations, track, piping, pumps and motors, and building. Also is included 15 per cent for contingencies and 7½ per cent for interest during construction.

TABLE III.—DRYING SLUDGE: COST OF SUPPLIES, ETC., PER DAY, BASED ON 96 TONS OF DRY MATERIAL.

Supplies:			
Coal—37 tons @ $1.75 f. o. b. cars		$64.75	
Oil, waste, etc.		1.00	
Lamp renewals		.25	
Repairs and renewals—			
Miscellaneous	$14.00		
Contingencies	15.00		
		29.00	
			$ 95.00
Labor:			
Foremen—½ time @ $3,600 for 1/300 year		$ 6.00	
Laborers—Crew of 11 men @ $7,920 for 1/300 year		26.40	
			32.40
Power:			
Lighting		10 H. P.	
Motors		200 H. P.	
		210 H. P.	
210 H. P. = 157 K. W. Hr. @ $1.007 = $1.10 per hr. for 24 hrs.			26.40
Interest:			
Interest on *$217,100 @ 5% =	$10,855		
Depreciation on 150,822 @ 7% =	10,558		
29,191 @ 5% =	1,460		
37,087 @ 4% =	1,483		
	$24,356 ÷ 1/300 =		81.19
Total			$234.99
Estimated cost per dry ton			2.45

*This figure represents cost of dryers, foundations, hoppers, conveyors, buildings, etc. Also included is 15 per cent for contingencies and 7½ per cent for interest during construction.

The estimates are based on the use of electrically driven centrifugal compressors of the type made by the De Laval Steam Turbine Co., or General Electric Co. These can be built to operate against any head, in ordinary service, whereas the rotary blower of the Connersville type is usually considered limited to pressures not exceeding 10 lb. per sq. in.

Air Distribution.—At the present time filtros plates offer the most satisfactory air distribution. Although the cost of maintenance may be somewhat higher than the perforated pipe grids, the distribution is better and the size of air bubbles is much smaller, with consequent increase in efficiency. The basswood plates, now being tested in Milwaukee, produce a remarkably fine bubble, insuring a considerable reduction in the use of air. The life of basswood plates is at present very uncertain, because of possible decay.

Power.—For the operation of air compressors, pumps, sludge presses, dryers, crane, electric lights and miscellaneous uses, approximately a maximum of 12,000-H. P. is required with an average use in 1920 of 7,500 H. P. during the day runs and at night as low as 4,200 H. P. The estimate is based on the price of electric power furnished by the Commonwealth Edison Co.

Sludge Handling.—The experience of the Sanitary District is similar to that at Cleveland, indicating that normal activated sludge will not dry as quickly or readily as Imhoff tank sludge. This appears to be an inherent difficulty in colloidal sludge. When applied to a sand bed, part of the sludge sinks, part floats, and the water separating out is between.

From the standpoint of recovery of material of value, the only way demonstrated at present is by filter pressing and heat drying. Possibly the yeast fermentation method developed at Dublin may afford a suitable alternative for filter pressing. So far it has not been tested on activated sludge.

A preliminary concentration appears necessary to reduce the excess water as much as possible. The experiments of the Sanitary District indicate that the sludge can be concentrated in volume on an average of 50 per cent in two to three hours quiescent settling. The depth of tank seems to have very slight influence on the moisture content of the concentrated sludge, depths of 10 and 20 ft. being apparently equally effective.

Filter Pressing.—The indications are that the sludge can be filter pressed, both by the older styles of filter press, where specially designed, and the novel platen press or the Berrigan type. As the latter press has been operated on a larger scale and proved somewhat more successful in producing a cake of uniform moisture content, the estimates are based on Berrigan presses, with leaves in size 6 by 9 ft., taking the 24-hour capacity of a unit press at 8,000 lb. of press-cake containing 75 per cent moisture. The press at Milwaukee actually handled 6,000 lb. of cake, using 8 sacks. Ten sacks can readily be used.

Sludge Pressing.—One important factor in the cost of operating the sludge presses is the renewal of the press cloths. The best available data is furnished by Mr. Matthew Gault, Superintendent of Sewers, Worcester, Mass. In Worcester from 6,000 to 10,000 yd. of duck, 40 in. wide, are used in a year, approximately 2.2 yd. per ton of dry solids, the figures fluctuating from 1.56 to 3.5. On the 40-in. width, this averages 2.44 sq. yd. per ton. To be safe 2.5 sq. yd. has been estimated per dry ton. The figures are based on the use of the No. 8 duck, 120 in. wide, the price being taken on January 10, 1917.

The charges are based on handling 96 tons of dry material per day. The cost of supplies will vary approximately with the number of tons actually handled. The labor cost, however, will not be so flexible, as a working crew would be required at all times. The summary of pressing and drying includes the cost of the building (Table IV). Table II gives the estimated daily cost on the basis of 96 tons of dry material per day.

Drying.—The sludge on leaving the filter press is assumed to average 75 per cent moisture content. This can be readily dried in direct or direct-indirect heat dryers of several types, to a moisture content of 10 per cent. Sewage sludge has been successfully handled in this manner in England. The estimates are based on direct heat dryers of the Ruggles-Coles type or equal. The equipment provided includes an air-washing chamber to condense the vapors derived from the moisture driven off. The evaporation in the dryers has been taken at eight pounds of water for each pound of coal. Undoubtedly Illinois screenings would be used. The cost of coal has been taken at $1.75 per ton, f. o. b. cars. This is low under present abnormal condition. Table III gives the estimated daily cost on the basis of 96 tons of dry material per day.

TABLE IV.—SUMMARY OF CONSTRUCTION COST OF ACTIVATED SLUDGE PLANT AT THE FORKS ELECTRICALLY DRIVEN, JANUARY, 1917.

Items.	Amount.
Aeration tanks—32 units	$ 778,140.00
Settling tanks—32 units	122,090.00
Sludge tanks—8 units	30,880.00
Skimming basin—1 unit	13,000.00
Piping—	
Air	160,920.00
Sewage	46,700.00
Sludge	25,700.00
Drainage	57,050.00
Water and flushing pipes	5,000.00
Screen and pump house	120,260.00
Compressors, mechanical equipment, house, etc.	564,080.00
Sludge press and drying house	784,340.00
Laboratory	7,500.00
Meter vault	5,920.00
Effluent conduits	11,350.00
Grading and grounds	59,300.00
Cofferdam and dock	94,000.00
Operating gallery	23,730.00
Intercepting sewer	124,650.00
	$3,034,610.00
Contingencies—omissions and engineering—15 per cent	455,190.00
Total	$3,489,800.00

TABLE V.—LABOR SCHEDULE OF ACTIVATED SLUDGE PLANT, BASED ON 3 WATCHES OF 8 HOURS EACH, JANUARY, 1917.

Men No.	Men Title.	Rate per year.	Total per year.
1	Superintendent	$2,500	$ 2,500
3	Assistant superintendent	1,800	5,400
3	Tank foremen	1,200	3,600
3	Press foremen	1,200	3,600
3	Engineers	1,200	3,600
6	Oilers	900	5,400
3	Firemen	900	2,700
9	Press operators	900	8,100
1	Electrician	1,500	1,500
1	Machinist	1.200	1,200
1	Steamfitter	1,500	1,500
1	Steamfitter helper	1,000	1,000
2	Seamstresses	720	1,440
	Laborers:		
3	Skimmers	720	2,160
11	Aeration and settling	720	7,920
30	Pressing	720	21,600
11	Drying	720	7,920
3	Miscellaneous	720	2,160
1	Chemist	2,000	2,000
1	Assistant chemist	1,500	1,500
1	Laboratory helper	900	900

TABLE VI.—SUMMARY OF CONSTRUCTION AND ANNUAL COST ELECTRICALLY DRIVEN ACTIVATED SLUDE PLANT

First cost:		
Construction cost		$3,489,800
Interest during construction		261,735
		$3,751,535
Annual cost:		
Operating—		
Salaries, superintendence, etc.	$ 7,900	
Labor pay roll	75,400	
Power	270,000	
Supplies and repairs	98,000	
		$455,700
Depreciation—		
Filtros—20 per cent on $70,000	$ 14,000	
Screens—10 per cent on $20,000	2,000	
Dryers, etc.—7 per cent on $350,000	24,500	
Boilers, etc.—5 per cent on $570,600	28,530	
Structures—4 per cent on $2,740,935	109,640	
		178,670
Interest—		
5 per cent on $3,751,535		187,577
Total		$821,947

Plant.—The estimates (Table IV) are based on the use of reinforced concrete throughout the grit chambers, grease skimmer, screen chamber, aeration and settling tanks; on mass concrete on all foundations for buildings, machinery, etc.; on neat brick buildings, with face brick outside and common brick inside, covered with fireproof roofs, supported on steel trusses. The machinery prices are based on a first-class grade of machinery throughout. All prices are based on current prices in December, 1916, so far as they could be obtained, and consequently are higher than normal for all machinery, steel work, cast-iron pipe and other steel or cast-iron manufactured products.

Operating Cost.—There is practically no available data on the cost of operation of an activated sludge plant of the size recommended herein, even on domestic sewage. Moreover, the character of the Stockyards sewage is such that the data on municipal practice cannot be directly applied, even where available. The operating figures from plants like Worcester and Providence have been helpful. The figures are estimated for this particular case.

In operating such a plant, the crews should be handled on an 8-hour basis, dividing the 24 hours of the day into 3 watches. The rates of pay are given in Table V.

Annual Cost.—The annual cost is summarized in Table VI, showing the estimated amount required for maintenance and operation, interest and depreciation. This cost may be reduced somewhat if the amount of solids recovered by drying and pressing is only 50 tons per day. The saving might amount to $65,000 more or less. The summary indicates that the power cost is one of the large items. This cost may be increased on account of heavier use of air during storms, by an amount possibly averaging $30,000 a year additional.

Bids Asked on 18-Mile Tunnel for San Francisco

The Board of Public Works of San Francisco, Cal., is now calling for bids for constructing 18 miles of tunnel aqueduct in the Mountain Division of the Hetch Hetchy Water Supply Project. The tunnel is to be of horseshoe section, lined with concrete, 10 ft. 3 in. height and width inside of lining. The estimated cost of work is about $2,000,000, and it is divided into three sections.

Shandahen Tunnel Letting Postponed

The Board of Water Supply of New York City has extended the date for opening bids for the construction of Shandahen Tunnel to Sept. 11. As originally advertised the proposals were to be in by July 17. This tunnel will be 18 miles in length and will connect the Schoharie reservoir with Escopus Creek. It will be 11½ ft. high by 10¼ ft. wide and will be lined with concrete.

Aeration of "Sulphur" Water in Florida

By GEORGE W. SIMONS, JR.

Chief Engineer, Bureau of Sanitary Engineering, State Board of Health

The underground water of Florida is very generally impregnated with hydrogen sulphide (H_2S) and consequently is widely termed as "sulphur water." In regions of artesian flow the sulphur taste and odor is most perceptible, for instance at Jacksonville, Pablo Beach, Kissimmee, Fort Myers and many east coast points.

The disagreeable hydrogen sulphide has its origin in one of several ways: (1) by decay of organic matter containing sulphur, (2) reduction of sulphates, (3) partial oxidation of sulphides, and other ways.

Mr. E. H. Sellards of the State Geological Survey claims that the sulphur in Florida's underground water obviously comes from the decay of organic matter, inasmuch as the soils of the state possess some sulphur content shown by chemical analysis; it also is invariably present in muck soils. Sulphur, moreover, in dried Florida peat varies from 1 to over 4 per cent.

Aerator Used by Jacksonville, Fla., Hotel.

As is well known, the amount of gas a water is capable of retaining in solution varies directly with the pressure—the law of the solubility of gases in liquids being applicable. Water at a great depth under a great pressure is capable of holding a large quantity of hydrogen sulphide gas in solution, but which upon reaching the surface, the pressure being relieved, escapes.

Water containing hydrogen sulphide can be freed from it by the simple process of aeration, allowing the water full benefit of the surrounding air. Recently, several aerators similar to the one illustrated have been placed in use with the result that all the sulphur gas has been released leaving a tasteless, odorless water for use. The aerator pictured is located on the property of a large hotel in Jacksonville. The well is free flowing, the overflow being intercepted by two circular galvanized iron disks placed as shown. These disks cause the water to overflow in very thin sheets allowing the air full access to the supply.

At first, when this aerator was placed in operation only one diverting disk was installed with the result that just a portion of the gas was removed and in the retaining reservoir a growth of sulphur organisms (Beggiatoa Alba) began to appear. These organisms grew rapidly with the favorable temperature filling the reservoir and covering the walls with a stringy characteristic growth. After the addition of the second diverting disk the troublesome growths were removed entirely, indicating that there was being affected an almost total removal of the gas.

A Logarithmic Diagram for Finding Brake Horse Power

The accompanying diagram, constructed by Louis Mitchell, Associate Professor of Civil Engineering at Syracuse University, for use in his work in the hydraulic laboratory at the University, will be found useful for quickly solving the equation for brake horsepower,

$$BHP = \frac{2\pi R N W}{33{,}000}.$$

The diagram is used as follows:

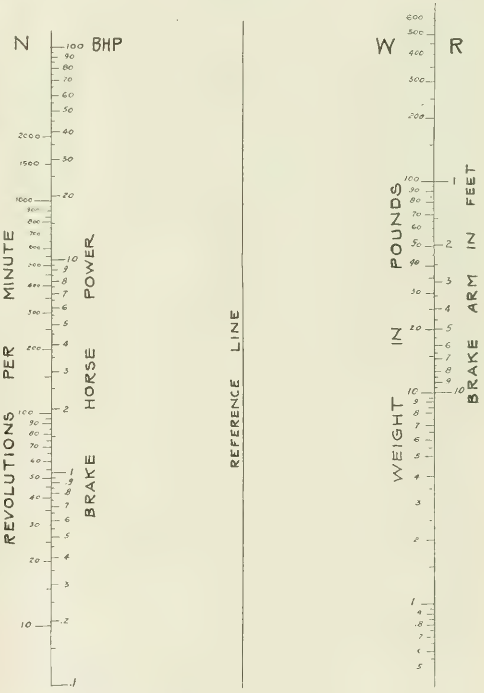
BHP = brake horsepower.

N = revolutions per minute.

W = net weight on the scales, pounds.

R = brake arm in feet.

Given N. W and R, to find BHP.



Logarithmic Diagram for Finding Brake Horse Power.

Lay a straight edge across the three vertical lines to intersect the given values of N and W and hold the point of intersection on the reference line with a pencil or pin. Swing the straight edge about this latter point until it intersects the given value of R, and in this position it will also intersect the correct value of the brake horsepower.

Drainage Methods for Irrigated Shale Land

Drainage is now recognized as one of the most important problems confronting the farmers of irrigated lands. Drainage methods in the arid regions differ from those in the humid sections, and even with respect to arid lands different methods must be used for different types of land. One of the frequently occurring types that requires special treatment is those lands that are immediately underlain by shale which may or may not outcrop. Areas of this type occur in all of the Rocky Mountain States and in some of those immediately adjoining. Drainage methods in the shale lands of the Rocky Mountain States are described in a recently issued bulletin of the Department of Agriculture, prepared by Dalton G. Miller, Senior Drainage Engineer, and L. J. Jessup, Junior Drainage Engineer, U. S. Office of Public Roads and Rural Engineering. The following notes are taken from this Bulletin.

Design Features.

Preliminary Examinations.—Effective drainage of shale lands depends upon the location and depth of the drains and upon the proper installation of relief wells. To locate the drains properly is a slow and laborious process, for it requires the mapping—or at least the gaining of a correct idea of the surface topography—of the underlying shale. This necessitates a large number of borings and very careful subsoil examinations, owing to the sudden changes and extreme irregularity in the shale topography. On some tracts the surface of the underlying shale is fairly regular and not a great many subsurface examinations are required, but in many instances the shale has been eroded into bad-land topography. The auger at one point may strike the top of a shale knoll, dome, or point immediately underlying the covering of soil, while 20 ft. away in any direction it will not encounter shale at a depth of 10 to 20 ft. Very narrow ridges often are found, the tops of which are near the ground surface, but a short distance on either side the shale is too deep to be reached by tile drains. A common occurrence in the shale formation is a very deep and quite wide arroyo running through a rather smooth area of shale, but with no indication of this deep depression, owing to the covering of soil.

Where only small areas are affected the shale knoll, or point, contributing the seepage water may be located sometimes by ascertaining from the landowner the spot where seepage first made its appearance. The damaging features of the underlying shale topography often can be quickly ascertained by a line of borings closely spaced along the upper edge of the affected area. Where large areas are affected, and where an idea must be gained of the topography of the shale underlying the entire district, perhaps the most rapid method is to begin with a boring at each of the extreme corners of the tract, then to subdivide the distances between these holes, continuing the process until a sufficient number of borings have been made to determine the general features, after which those spots or localities which seem to overlie points or ridges can be more carefully examined. In cases where the conditions are very complex, and it is desired to map the underlying shale, it is best to space the majority of the holes regularly over the area in question.

The topography of the underlying shale usually resembles the present surface topography in a very general way. In the bottom or older portions of a valley that are more or less even and uniform, the underlying shale usually is also fairly smooth. On the slopes the more pronounced ridges are often underlain by shale ridges which represent the general trend of the system of shale topography. Frequently outcroppings of shale will give an idea of the underlying features. In some cases large underlying shale draws can be located by noting the gaps and openings in hills forming the rim of the valley. A knowledge of the kind of shale being dealt with and its characteristic topographic features is of value in gaining a general idea of its surface.

In making the examinations a small stake should be driven at each hole and the stakes numbered consecutively. If a map is to be made, the depth to shale should be kept in a note book. Otherwise the depth to shale should be marked on each stake in order to facilitate locating the drains along the ridges and other higher portions of shale.

The weathered, flakelike covering of the shale ridges, mixed with soil, frequently makes it difficult to determine the true depth to the solid shale formation, as pockets of coarse shalelike material occur in the soil and may be far from any shale formation; consequently examinations of borings from small auger holes frequently are misleading. Where there is any doubt, holes should be continued for some depth after encountering the shale to make sure that it is the solid formation. Occasionally, where the exact depth to shale seems uncertain, it can be ascertained best by excavating a pit.

Location of Drains.—Attempts to accomplish drainage by running tile lines across and along the upper edge of the affected area thereby cutting into a number of shale ridges and points contributing water, have proved unsatisfactory: (1) because of the absence of an impervious stratum that can be reached by the tile, the lack of which permits some of the water to pass freely below the tile to a point farther down the slope; (2) these ridges do not discharge water at their points alone, but frequently along the sides also. This is due to the fact that pressure exists and the water is supplied at various points from the continuous shale formation beneath the shale ridge.

These complex conditions existing in the shale make it imperative that the drainage lines should follow as nearly as possible along the backbone of the shale ridges or cut through the knolls and other high portions. Usually the lines should extend for some distance up the ridge or other formation above the affected area. Not only is it necessary to run the tile lines along the shale ridges to secure the best results, but trenching in the shale is far easier than in wet adobe soils. Where quite broad shale ridges are encountered, one line will be insufficient: on such ridges a tile line should extend along each side.

Where a number of shale ridges that are supplying the seepage water are encountered the main line should, if possible, run along the points of these ridges, with a branch following up each ridge. As not all shale ridges, or points, furnish seepage water, a number of deep holes should be put down into the shale, noting the degree of hardness, whether or not soft layers are encountered, the amount of water found, and whether or not pressure conditions exist. It is very important that none of these shale points that contribute water be missed, for, although the system may develop a considerable quantity of water from the points tapped, any remaining one will furnish enough water to these retentive adobe soils to prevent complete reclamation.

In the drainage of those lands underlain by shale that has no distinctive topographic features, but which is smooth and at a fairly uniform depth below the surface of the soil, a system should be employed which has branches spaced at regular intervals and extending up the slope. However, the determination of the interval required for the branch lines necessitates a careful examination of the shale. Experience in drilling often will enable one to determine whether or not the shale is traversed by systems of small crevices; the drill takes hold with more difficulty in shale that does not contain them than in shale that does. The nature of the borings brought out on the auger is indicative also of the presence or absence of such crevices. If the borings are fine-grained and more or less compact, few or no crevices are probable; but flakey, mealy borings indicate the contrary. By those unfamiliar with the mode of occurrence of water in shale those zones containing water often will be overlooked, for the small lumps and layers of shale between the cracks are impervious in themselves, and the auger, passing through these, will bring up fragments of perfectly dry shale, while the free water frequently found between these dry borings will be thought to have collected there in pulling the auger out through the upper wet portions of soil.

The existence of pressure often can be detected after having struck cracks in the shale containing water, by placing the ear near the hole; a hissing sound caused by the escape of the water from the small crevice into the larger opening is an almost certain indication of pressure conditions. The intensity of the pressure can be estimated by the rapidity and height of rise of the water in the well. Often the water will rise several feet within a few minutes, and again it may require a day or two for it to attain its maximum height. Where the water rises only a few inches, and that very slowly, the pressure is slight or negligible. High pressure is indicated by a rapid and high rise of the water. Of course, the height and rapidity of rise depend somewhat on the season, there being generally a seasonal fluctuation of the water table. In seasons of high water table, pressure strong enough to cause these wells to flow on the surface is encountered frequently.

The borings will indicate certain spots and streaks where the pressure seems high and the water free; drainage lines should be located to tap these areas. In the location of drains in those lands underlain by hard and practically impervious shale interception methods can be used, provided the shale surface is even and sufficiently near the ground surface to be reached by a tile drain throughout the entire length of the line; otherwise this method can not be used, and the overlying soil must be drained by a relief system.

Depth of Drains.—The tendency in the arid West has been toward increasing the depth of drainage; this has been true especially with regard to shale lands. The distance through which capillarity takes place is one of the important factors regulating the minimum. Water passing upward through the soil by capillary action carries salts in solution and by evaporation deposits them on the surface of the ground. The height to which capillary water will rise depends on the type of soil, its wetness and temperature, and, to some extent, on the kind of salts. High temperatures and certain salts increase the range of capillarity. In loose, sandy soils the rise is not great; in average soils of the arid West it probably ranges from 2 to 4 ft., and in clayey soils more than this. Of all the types of soils, the adobes encountered in the drainage of shale lands are perhaps most conducive to a high range of capillarity; thus the necessity for deep drainage.

One of the greatest advantages of deep drainage in this type of land is the increase of flow of the relief wells thus obtained. However, there is a practical limit to the maximum depth, and it is believed that in the design of a drainage system the depth should be fixed with reference to that limit rather than by setting a minimum limit determined by capillarity, depth of root zone, etc. The practical limit of depth, of course, would vary somewhat as between hand work and machine work. It would depend also upon the nature of the ground encountered. In the presence of these variable factors it becomes impossible to fix a maximum depth, but the minimum should be not less than 6 ft. and in many cases should be 7 or 8 ft.

Relief Wells.—In the drainage of many types of shale land the installation of relief wells is absolutely necessary for the success of the drainage system. A relief well is nothing more nor less than an artesian well. Its purpose is to connect the tile line with the deeper strata which are the sources of the seepage water and thus, by permitting the water to pass out freely, to relieve the pressure. While no rigid rule can be given for the spacing and location of wells, experience has shown that from two to six for each 100-ft. length of trench will be necessary ordinarily. Where the conditions in the trench are uniform, the wells should be spaced regularly if the resulting flows are uniform; but if, after putting down a hole or two, very little or no flow results, it is advisable to space them farther apart until an area is encountered where more water is developed. The proper depth for relief wells is a matter for experiment in different localities. The maximum depth, however, usually is about 20 ft. below the bottom of the drains. In beginning work on a new project it always is advisable to drill the first two or three wells deep to determine where the flow is most apt to be encountered. While water will not be encountered at uniform depths, yet certain limits within which it is likely to occur will be determined. In nearly all cases observed 2-in. wells have been of sufficient size to care for the water developed.

Construction.

Construction of drainage systems in shale lands has varied greatly in respect to difficulty of installation and cost. Much of the shale is quite hard, or contains hard concretions, which makes necessary the use of picks. Trenches where the greater depths are in solid shale stand well and need little or no bracing if the work is handled properly. Shale makes a very good foundation for laying tile, and the coarse, broken shale is good material for blinding the tile.

Generally speaking, the work in shale is not difficult but trenching in the saturated adobe soil is a real problem. Outlet lines usually have to pass for considerable distances through soil not immediately underlain by shale, and in many lines the upper several feet of the trench must be excavated through the soil before the shale is reached. With the exception of saturated fine sand or quicksand, no class of material is more difficult to handle than adobe. When partly saturated it becomes sticky and adheres to the materials and tools with a tenacity that makes progress difficult and tedious. The skeleton spade is the only tool that will handle it with any degree of success. The ordinary shovel will not scour. When this soil becomes completely saturated it often assumes a semifluid state that makes the use of tight sheeting necessary; frequently, not only must the sides of the trench be sheeted, but also the face.

The most successful cribbing in such material consists of two heavy timbers, held apart by trench jacks, behind which is driven the vertical lumber sheeting. The boards should fit tightly; they may be driven with a heavy maul and removed with a light derrick or grabhook. Where the sheeting is driven and pulled by hand, planed 2 by 6-in. planks have been found the most satisfactory. Sizes larger than this are driven and pulled with difficulty. The bottom end of each of these planks should have a long bevel on one side, so that it will drive readily and straight. The tops of the planks should be beveled slightly, or a cap used to prevent "brooming" while being driven, and the planks should be long enough to extend below the grade line. As the material is excavated, two more heavy planks should be placed near the bottom and held apart by trench jacks to prevent the weight of the material from displacing the bottom of the sheeting. These can be used also for the workmen to stand on when the bottom of the trench becomes too soft. In the latter event it becomes necessary to place boards under the tile in order to hold them on the grade and prevent them from sinking. When large-sized tile are used a cradle must be placed under them. This cradle resembles a ladder, the strips running lengthwise being of 2-in. material and spaced so that the sides of the tile will rest against them as well as on the crosspieces of broad 1-in. lumber. The tile should be covered by some material such as cinders, gravel, or broken shale. Hay and straw have been used with success. The tile should be well blinded and weighted down before removing the sheeting, which should be pulled slowly and carefully to prevent the soft material that sloughs in from the sides from pushing the tile off grade. Trenching machines especially built with shields for soft material would handle some of these soils satisfactorily.

The excavation of ditches should begin at their outlets or at their junctions with other drains and proceed toward the upper end. Trenching should be done as neatly as possible and should follow closely the line of stakes; where the drain changes direction the turn should be made by a neat curve. If possible, the top soil should be thrown out on one side of the ditch and the shale on the other, and in back-filling the shale should be put in first.

No attempt should be made to grade the tile by the water in the ditch. Grades for the drains always should be established by surveys, and the ditch should be dug accurately to the depths specified; these depths should be measured from the grade stakes set for that purpose, and the ditch graded evenly on the bottom by means of the "line and gage" method or by any other equally accurate device for obtaining an even and true bottom upon which to lay the tile.

The tile should be laid as close as possible, beginning at the lower end and proceeding upstream. They should be turned about until their upper edges close. If there is silt or other fine material that is likely to run into the tile, the lower edges must be laid close and the joint surrounded by cinders, gravel, or other suitable material. If, in making turns or by reason of an irregularly shaped tile, a crack ¼ in. or more is left, it must be covered securely by broken tile. All junctions at manholes and branches should be made securely. Care must be exercised to prevent sediment from washing into the tile, and when each drain is complete it should be free from sand, mud, or other obstructions.

The tile should be hauled and distributed along the line of trench all in one operation. They should be hard-burned clay tile of good quality, preferably in 2-ft. lengths. They should have smooth interior surfaces and should be hard burned entirely through, of uniform texture, and free from lime or other impurities. No piece should vary from a straight line more than ½ in. for a 2-ft. length. No tile should be used that has a piece broken from either end deeper than 1½ in. After the tile are laid they should be covered carefully to a depth of at least 6 in. with broken shale, gravel, or coarse cinders.

Relief wells can be installed with a 2-in. auger, or where hard strata are encountered a churn drill can be used. Each well should be located so that it will come near the end of a tile; it is then connected with the line by chipping out one end of the tile with a wrench, so as to leave a hole about 2 in. in diameter over the well. All wells must be connected, regardless of whether they flow or not, for they may flow later.

Where the banks of the trench stand up well, the tile where wells are desired should be left with but little blinding over them; after the line is completed a tile can be taken up at each of these places and the well installed. In this case the wells can be placed directly beneath the tile. In trenches where the banks will not stand, it becomes necessary to drill the wells as the tile laying progresses, and they should be placed a few inches to one side and connected with the opening in the tile by placing a half tile over the well. They should not be placed directly beneath the tile, for the sediment washing down from the construction work above is apt to fill up the weak or non-flowing wells.

Cost Data.

It is believed that the tracts from which the following data were obtained are fairly representative of conditions as ordinarily encountered in this type of drainage; consequently the unit costs may be assumed to indicate fairly what may be expected in excavating in this sort of material by hand labor.

With labor at $0.25 per hour, actual unit costs for excavating, laying tile and back-filling trenches in shale ranging from 6 to 7 ft. in depth averaged $.12 per linear foot on four small projects aggregating a total of 4.430 ft. of trench. A contract job of 2.768 ft. of 7-ft. trench was let for $0.20 per linear foot, while another job of 5,600 ft., running 6 ft. in depth, was let so as to average about $0.11½ per linear foot. These figures do not include the cost of boring relief wells in the bottoms of the trenches. However, taking the work as a whole, this need not increase the cost by more than an average of $0.02 per foot, as there are nearly always some portions of trench on any job in which the relief wells are not essential. The cost of boring the relief wells probably averages about $0.05 per linear foot of well where the depth below the bottom of the trench runs from 8 to 16 ft. Where the depths vary from 16 to 25 ft. the cost per foot of well may run as high as $0.10 per lineal foot, especially if much sand rock, lime rock, or other hard material be encountered that renders necessary the use of a drill.

Deterioration of Carrying Capacity of Cast Iron Pipe

Interesting information on the incrustation of water mains was given by Mr. Burt B. Hodgman, Chief Engineer, National Water Main Cleaning Co., New York City, in a paper presented at the recent convention of the American Waterworks Association. Extracts from the paper follow.

About two years ago a series of questions was sent out to water works superintendents and engineers all over the United States, asking for their experience with various kinds of water mains. Answers were received covering users of more than 15,000 miles of cast iron pipe. These answers came from nearly every State in the Union and almost without exception the answers stated that the outside surface of the iron was in excellent condition. There were some exceptions, but where those exceptions occurred there was some special condition covering them. This of course does not cover the question of electrolysis, but that should be considered a special condition the same as pitting on the outside which occurs in cast iron mains laid in peat bogs or laid in cinders, but with the interior surface it is a different thing.

Incrustation or scale results from several different causes. Probably the principal cause is iron corrosion due to the soft waters which are impregnated with free carbonic acid, crenothrix, or some kindred source of trouble such as the presence of manganese, sulphur, organic acids or mineral acids, all of which will greatly accelerate the incrustation of these mains. Also it should be noted that greater corrosion takes place in pipes which have free iron exposed as in the case where the line is frequently tapped. This may be due to galvanic action. It is, nevertheless, a fact that the same water passing through a tar coated line which has not been tapped will affect that pipe less rapidly than will the same kind of water where corporation cocks have been placed at frequent intervals. There are, of course, other incrustants, such as pipe sponge, pipe moss, etc.

Besides the iron corrosion, we have various deposits found in mains due either to sedimentation or the settling of lime in the water after treatment for softening or the deposit of lime stone such as is found in Salt Lake City, Utah, or the deposit of mud, also the deposit of red mud due to the presence of free iron in some waters, particularly ground waters. These deposits take place in many different forms. The red mud deposits all around the pipe in a wavy surface which retards the flow very much. Then there is a clay deposit such as that found from the Big Muddy River in Southern Illinois, where the clay mud deposits all around the pipe concentrically, in one case to the extent of cutting an 8-in. pipe to an open area of 5-in. and the surface of this also was wavy, further reducing the carrying capacity of that pipe. Then there are the waters which deposit mud in the bottom of the pipe, sometimes filling mains to more than one-half their diameter. This form of sedimentation is found in almost every part of the United States where turbid waters are pumped.

A list of tests is submitted herewith (Table I) showing the approximate number of years pipes in various localities have been down, the kinds of water passing through them and the percentage of carrying capacity lost, due to this corrosion. These tests, while not numerous enough to form the basis for definite conclusions, still may perhaps be of use to the superintendent in determining what his conditions and his troubles may come from.

Many of the tables on the flow of water in cast iron pipes give a coefficient to use for pipe a certain number of years old. These coefficients are so variable that it seems better to find out what the local conditions are for each particular place before deciding what a pipe will carry after being a certain number of years in service. Some comparatively hard waters such as that of the Great Lakes, for instance, may flow through cast iron pipe for 20 years without seriously affecting the carrying capacity, while the waters of the Ohio River almost invariably destroy the carrying capacity to a very large extent in that length of time. In New England the surface waters in general will probably reduce the carrying capacity of small mains from 25 per cent to 40 per cent in 20 years. Some of the snow waters of the Pacific Coast have destroyed the carrying capacity of cast iron pipe to the extent of 50 per cent in 20 years. Some of the Southern surface waters which are very soft and in cases contain organic acids have been known to destroy 75 per cent to 80 per cent of the carrying capacity of small mains in a period of 20 years. The upper Mississippi, which at times runs very high in hardness, seems to affect pipe but very slightly, excepting where the water has been softened, thereby causing a heavy rough deposit of lime.

TABLE I.—AGE OF PIPES AND CARRYING CAPACITY LOST DUE TO CORROSION.

Locality.	Kind of water	Size. In.	Age of pipe. Years.	Capacity Lost. Per Cent.	Special conditions.
South Milwaukee, Wis.	Lake Michigan	10	15	18	Hardness 180-200.
Chicago, Ill.	Lake Michigan	6	30	32	Hardness 180-200.
Rochester, N. Y.	Lake fed by springs	4	25	25	Spring water.
New Jersey	Ground	6	30	34	Iron deposit.
Missouri	Mississippi and Missouri Rivers	20	21	50	Lime and iron treatment
Rochester, N. Y.	Genesee River	12	28	52	Surface water.
Lockport, N. Y.	Erie Canal	6	20	54	Polluted with sewage.
Salt Lake City, Utah	Mountain water	6-16	20-25	50-65	Hardness very high.
Camden, N. J.	Ground water	8	55	60	
Philadelphia, Pa.	Surface water	6	70	56	Hardness 180 parts per million.
Cumberland, Md.	Potomac River	6	26	50	Hardness 100-120.
California	Mountain snows	16	18	50	Very soft.
Meridian, Miss.	Surface and spring	16	..	50	Soft; sometimes acid.
Madison, Ind.	Ohio River	6	25	60	Soft and sediment.
New York	Surface	..	31	70	Soft water.
Kansas	Missouri River	10	28	62	Treated with lime; hardness 300-450 parts.
Kansas	Missouri River	24	21	44	
Mt. Vernon, Ill.	Surface water	6	18	75	Manganese present.
Arkansas	Arkansas River	6	20	78	High in salt and hardness.
Missouri	Ground water	4	20	80	Sulphur and other minerals.
Philadelphia, Pa.	Surface water	6	70	56	Hardness 180 parts per million.
Huntington, W. Va.	Ohio River	6	20	75	Soft, with mineral acids.
Wheeling, W. Va.	Ohio River	6	20	80	Soft, with mineral acids.
Illinois	Surface water	6	31	70	Soft water.
Long Island	Ground water	12	50	80	Soft.
Boston, Mass.	Surface water	16	59	47	Soft water.
St. Louis, Mo.	River water	6	25	63	Treated water.
Meriden, Conn.	Surface water	12	..	49	Soft.
Connecticut	Surface water	36	27	32	Soft.

This is more or less true also of the Missouri River or Central Plains waters. Then there is the Arkansas River water which runs very high in salt as well as alkalinity, and in the small pipes supplied from this water we frequently find 50 per cent to 60 per cent of the carrying capacity destroyed in a period of 20 years.

To give the superintendent an idea of the effect of corrosion on small pipe (6-in to 12-in.) so that he may judge of his local conditions by noting the interior of his mains when cuts are made, the following estimates are given:

Tubercules from ⅛ in. to ¼ in. in depth, occurring principally at the bottom of the interior surface of the pipe, will cut the carrying capacity from 15 per cent to 20 per cent.

Tubercules from ⅛-in. to ⅜-in. in depth, covering practically the entire inner surface of the pipe, will cut the carrying capacity from 35 per cent to 40 per cent.

Tubercules from ¼-in. to ½-in. in depth, covering the entire inner surface of the pipe, will cut the carrying capacity from 45 per cent to 50 per cent.

Tubercules from ½-in. to 1-in. in depth all around the inner surface of the pipe will cut the carrying capacity down from 70 per cent to 75 per cent.

To determine the effect of this corrosion on the pipe some 25 samples altogether have been analyzed to determine the exact amount of the iron from the pipe which has been destroyed, and we find in the worst samples examined that the rate of destruction is only about 1/10 of 1 per cent per year, or 10 per cent of the iron in 100 years. We find in some isolated cases that underneath these tubercules there is a slight pitting, but even though the pipes are scraped, some scale is left covering this pitting and forms more or less of a protective coating to the iron at that point, and as a very large factor of safety is used in the designing of cast iron pipe this pitting could be many times as bad as it grows, or as it has been in any place so far observed without seriously endangering the strength of the pipe.

The percentage of carrying capacity lost in large pipes is not as great as that in small pipes, due principally to the fact the percentage of area filled by corrosion in the large pipes is not as great as that in the small pipes.

Extinguishing a $4,500,000 Gas Well Fire

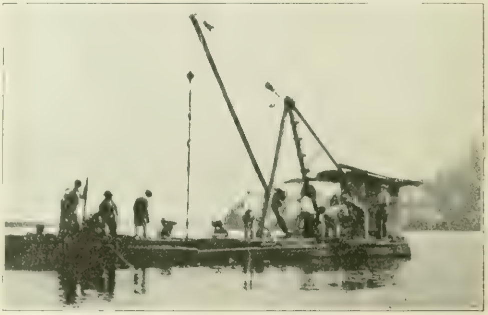
A gas well fire, 17 miles west of Monroe, La., was extinguished by means of water from hose lines. The well had a flow of 44,000,000 cu. ft. per day under a head pressure of 1,500 lb. The fire started on June 16 and was put out on June 22 after it had been burning for 5½ days. At the suggestion of William Guerin, former deputy chief of the New York fire department, two hose lines working under very high pressure were led up to the well as close as possible and the water turned on. After cooling the ground and what remained of the pipe the two lines of hose, opposed to each other, were gradually raised. Meeting as they did in the column of gas, as soon as the stream reached the base of the flame the water was turned into steam which formed a curtain, shutting off the gas from the blaze above in such a way that the fire was extinguished.

Method of Laying 14,000 Ft. Submerged Universal Pipe Line

Universal pipe was used in the construction last year of a 14,000-ft. submerged pipe line at Puerto Barrios, Gautemala. The 8-in. submerged section is a portion of a 5½-mile line that will bring a water supply to the city from a mountain stream. The pipe was laid across an arm of the bay, the maximum depth of the water being 24 ft.; the bottom was ooze. Universal pipe also was used for the land portion of the line. The methods employed in the laying of the submerged line were described by Mr. T. Howard Barnes, in a paper presented before the Richmond Convention of the American Water Works Association, from which the following is abstracted:

The method of laying was as follows: Two small deck lighters or floats were strapped side by side with about 6 ft. clear space, forming a catamaran. A trussed trough tailing into a pair of long planks, and having a sliding way for paying off the pipe was suspended near its upper end from a light framed derrick on one of the lighters. To the cradle were attached sufficient barrel floats to make it nearly buoyant when supporting the pipe.

The length of the cradle with its tail planks was finally made 100 ft., sufficient to reach the bottom at a slope of about 14°. This length was at first not so great, but later was made so.



Catamaran Employed in Laying Submerged Pipe Line.

The pipes lay net 6 ft. For submerged use they were tested again on the ground, eliminating about 40 pieces out of the 2,400 laid under the water, or 1 in 60. The joints were smeared with red lead. The ears, of course, were kept in a horizontal position, so as to permit vertical deflection in the pipe. The bolts were enveloped in a mixture of crude oil and cement held in place by muslin.

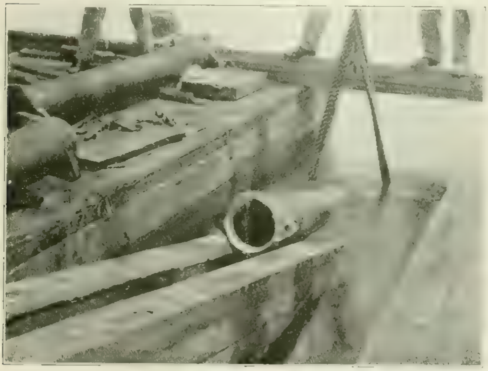
The use of red lead was adopted on the joints for subaqueous work. It has been found that red lead adheres better than white for wet work. For earth trenches white lead was used. The bolts on land were protected by lean cement-sand mortar and bound in muslin. This was because the trenches were shallow and organic material was likely to rust the bolts rapidly.

The position of the catamaran was manipulated and maintained by six lines, two each forward, aft and abreast, while alignment was maintained by tall ranges on shore. Progress was quite rapid as a rule. To guard against accident from squalls, the cradle and pipe were lowered each night and noon, whenever the work was suspended. Work began Aug. 24, 1916, and the last pipe was laid Oct. 19, 1916. The number of working days was 47 in laying 14,400 ft. of pipe. The average per day was 306 ft. The biggest day's work was 600 ft., and for one week 2,982 ft.

At intervals of about 100 pieces, a water test was applied by means of a hand pump. When about 7,000 ft. had been laid the test failed to show a pressure on the gauge. Air was then applied and two or three issues located. Work was not arrested, but a diver was sent for to make an examination. While waiting for the arrival of the diver, the pipe laying was finished.

The air issues indicated accurately the situation of the broken pipes. There proved to be seven in all. Of these two were in pipe split lengthwise and five where there were annular cracks at the shoulder of the toolwork against the rough iron. These fractures were probably due to too much deflection in tailing off from the cradle to the bottom in the case of pipe laid before the cradle was lengthened. It is also probable that the sea chop at times produced a compression on the side of some joints at the tail of the cradle.

It was demonstrated in the repairs that single pipes were easily removed. The oil cement mortar for protecting the bolts against rusting rendered the removal easy and lifting two pieces each way from the defective one sufficed to liberate the latter and admit the new pipe.



Pipe on the Ways of the Catamaran.

The experience recounted of the use of this joint indicates a possibility in laying submerged lines with greater economy than has been thought possible for similar situations. It is believed that it is possible to lay this pipe in certain submerged situations up to the limit of the sizes where only a single pair of ears are required.

Attention should be called to the favorable circumstances obtaining as to bedding of the pipe in this instance. The sea bottom is a pure bed of ooze into which the pipe sank for nearly its full diameter in the process of laying. The bed is, therefore, one ideally prepared by nature. The lightness of the pipe lengths for transporting was an important factor. The facility for jointing in this region of crude help and adverse weather was also a favorable circumstance. This feature was likewise appreciated in the land portions, where swamp and declivity presented difficulties in handling heavy pieces.

The final air test was 60 lb., initial pressure, which in 24 hours reduced to 40 lb.

The cost of the labor on the 14,400-ft. submerged portion of the work was about as follows:

	Cost.	Cost per foot.
Pipe testing, handling and laying	$1,600.00	$0.1111
Hire of launch	320.00	.0222
Building cradle	100.00	.0069
Repairs and preparation of catamaran	150.00	.0104
Storing of plant after finishing job	150.00	.0104
Replacing defective pipe, line tests, etc. (includes about $350 expenses for diver and helper sent from the United States but not retained)	900.00	.0625
Total	$3,220.00	$0.2235

Use of Automobiles for Survey Work for Irrigation Project

The advantages of automobiles for transporting field parties between camp and work are outlined in the June Reclamation Record by Mr. O. T. Reedy, Construction Engineer, U. S. Reclamation Service. The article, practically in full, follows.

The Fort Laramie unit of the North Platte project is now operating four automobiles. The first was received in February, 1916, and was used by the construction engineer and his principal assistant for supervising construction work. As the season opened up one machine was found to be inadequate for this purpose, and another was purchased in April, so that each of the engineers last mentioned was assigned the use of a car. In the same month a camp was organized about 25 miles down the valley and placed in charge of an assistant engineer who had considerable territory to cover, and a car was purchased for his use. It is to be noted that the primary use to which these three cars were put is that of supervisory work. The work under consideration consisted principally of the construction of 42 miles of main canal, involving the handling of 4,500,000 cu. yd. of material, and the advance location and cross-sectioning of an additional 20 miles.

While the primary use of these cars has been that of supervisory work, all of them have been in use more or less on survey work. In November, 1916, it was found advisable to assign one of these cars to a field party for the sole use of survey and construction engineering work, and a new car was purchased for the use of the construction engineer. The party using this car is in charge of Mr. H. J. Woodman, junior engineer, and is assigned the care of about 11 miles of heavy canal construction (in fact, the heaviest on the unit with the exception of the Springer Cut at mile 60), including four of the largest structures on the unit. These structures consist of tunnel No. 1, 2,700 ft. long; tunnel No. 2, 2,150 ft. long; Laramie River and Deer Creek siphons.

The work required of this party has been increasing to such an extent that it was seen that the necessity would soon arise for putting on another party. The men were so rushed that on many occasions they had to do their surface work in the daytime and a considerable portion of the tunnel work at night. A careful analysis was made of the time spent each day and it was found that between 30 and 50 per cent of the time was used up on the road going from one job to another, and the party chief presented evidence to the effect that one party could handle all this work if they were supplied with a car in order to reduce the travel time. This was done and the experiment has proved to be more than satisfactory.

The cost of a machine laid down at this station is $403.05. The cost of a suitable team, spring wagon, and harness is about $450 more. An outright saving in equipment through this arrangement was about $497, since the team equipment already in use could be transferred to construction work, and the one car, therefore, took the place of two team outfits. In addition to this there is a saving of the salaries of one engineering party amounting to a minimum of $230 per month.

The accompanying tabulation gives comparative cost records covering the operation of the four automobiles in use on this unit, and the team costs for the four corrals on the unit.

Automobiles.	Period cost record months.	Average maintenance per month.	Character of work requiring vehicle.
"F"	11	$25.50	95 per cent supervision; 5 per cent survey.
"G"	9	28.20	60 per cent supervision; 40 per cent survey.
"H"	9	19.75	85 per cent supervision; 15 per cent survey.
"L"	1	10.69	100 per cent supervision (220 miles).
Team.			
Port Laramie corral....	16	29.34	40 per cent survey; 60 per cent construction and general.
Cherry Creek corral....	8	30.12	70 per cent survey; 30 per cent general.
London flats corral.....	13	46.26	60 per cent survey; 40 per cent construction and general.
Box Elder corral........	4	36.60	90 per cent survey; 10 per cent general.

The actual monthly expense for the three months that car "G" has been used exclusively on survey work is $37.55. The detail costs are shown in the accompanying tabulation.

		Unit cost per mile.					
Month.	Miles.	Gasoline.	Lubrication.	Repairs.	Supplies.	Total unit.	Total monthly.
1916.							
November	466	$0.031	$0.005	$0.010	$0.042	$0.088	$41.00
December	431	.032	.005	.015	.011	.063	27.10
1917.							
January	550	.033	.002	.014	.032	.081	44.55
Average							$37.55

It should be noted that the tabulation covers three winter months, which in itself is sufficient reason for a considerable increase in the monthly cost. While it is possible to some extent to select the milder days upon which the road conditions are easier to do the work of supervision, it is imperative that the survey car be on the road day after day practically irrespective of roads and weather, on account of the requirements for lines and grades in the several tunnel headings.

Another factor that has increased the cost of operating the survey car during the last three months is that during that time it has traveled over the most difficult roads, aside from the incident of their being made so by the winter weather, of any on the unit. While the cars whose use has been practically only for supervision work have also been required to travel over these heavy roads they have had a considerable amount of travel in longer trips over fairly good roads to bring down the average. The soil at the upper end of the project is very sandy and roads are exceedingly heavy for at least 75 per cent of the year. During the infrequent wet spells they are in very fair condition, but this is so seldom that most of the time one forgets that there is any such thing as good roads on this corner of the project.

It is the opinion of the writer that the costs shown for atuomobile "G" covering the full 9-month period in which it was used both for supervision and survey work will be about the average cost for an automobile used exclusively on survey work the year round and on the average roads of the unit. Attention is called to the fact that while this is the highest monthly cost of any automobile on the unit it is lower than the team cost for any corral on the unit. The camp whose teamwork is more nearly comparable in character with that of automobile "G" is Box Elder camp, which has an average monthly cost of $36.60, or 30 per cent more than that of the automobile. However, this camp has been established only three months, and it is reasonable to suppose that later the corral cost will be somewhat reduced, probably to somewhere in the neighborhood of that shown for Cherry Creek camp, or $30.12, which is a little less than 7 per cent more than that of the outomobile. When these figures are considered in connection with the fact that the capacity of the survey party, especially on the construction work, is increased from 50 to 80 per cent, and that the cost of camp installation and equipment is correspondingly decreased, due to fewer camps required, the argument in favor of the automobile is almost without opposition.

Since becoming convinced of the economy of operating automobiles in place of team and wagon outfits for survey operation we are intending to work into this system exclusively as fast as new equipment is required. Of course it is always necessary to have at least one team in each large camp, but only incidentally for any survey work, since it has been found on the work we have been discussing that during the months of November, December, and January there were only two days that the car could not make its regular runs on account of the weather, and on these two days the weather was so severe that the men elected to walk to the tunnel work rather than to try to battle along, even with a team.

Of course the conditions which are most unfavorable for the use of the automobile in survey work are those of a new country, where the roads are not opened up. Circumstances recently arose, however, in which we were compelled to adopt this method of transportation in work across undeveloped country. Orders were received to rush with all possible haste certain advance location surveys, the results from which were urgently needed. This was in the middle of the winter, and on account of the weather and the lack of temporary camping facilities it was necessary to carry on this work from such camps as were already established. To do this by means of teams would be out of the question, as even at the start 50 per cent of the working day would be required on the road, and it would not be very long before there would be no time to work at all, as the men would have to immediately turn around and return home as soon as they reached the field.

The principal assistant to the construction engineer took charge of this work personally and used the automobile assigned to him as well as the one assigned to the construction engineer and also that of the assistant engineer at Cherry Creek Camp. In this way the work was pushed very rapidly, notwithstanding the adverse conditions, and it has been found that even under such circumstances the automobile is more advantageous and at least as economical as the use of the team outfits.

It is our practice as soon as the canal is located to attach a riding plow behind a heavy wagon and plow two furrows, whose distance apart is that of the automobile track, on the lower side of the located canal, and in this way a road which reaches to any part of the work is secured at very little expense. Of course these furrows can not be plowed when the ground is frozen, a condition which operated to subtract from the efficiency of the automobile in the advance survey work just discussed.

A Page from Recent Water Works Reports

Cost of Furnishing Ice for Drinking Fountains.—During 1915 the Water Board of Cambridge, Mass., maintained eight ice water drinking fountains. This practice was started in 1904. The cost of furnishing the fountains with ice during the summer months for the past 12 years has been as follows:

Year	Number.	Total cost per year.	Average cost per day per fountain.
1904	4	$460.35	$1.20
1905	4	514.18	.94
*1906	5	795.64	1.57
1907	6	655.49	1.09
1908	6	705.99	1.04
1909	6	823.48	1.15
1910	5	712.65	1.24
1911	5	734.20	1.34
1912	7	918.75	1.25
§1913	7	970.81	.97
†1914	7	747.68	.78
†1915	8	719.83	.74

*Prices of ice in 1906 were 25 ct. and 40 ct. per 100 lb.; in other years 12½ ct. and 15 ct. per 100 lb.

§Again, in 1913, the price of ice was 25c per 100 lb.

†A very cool summer.

Leaks in Distributing System of Cambridge, Mass.—The number of leaks per mile of the distributing system of Cambridge, Mass., for the year April 1, 1915-March 31, 1916, was 1.40. In all 187 leaks were reported and repaired by the Water Department. These were distributed as follows: 139 on supplies, 8 on hydrants, 10 on main pipe joints, 10 on gates, 2 on blow-offs, 2 on standpipes (street watering), 1 on service box, 3 on 4-in. main pipes, 5 on 6-in. main pipes, 1 on 8-in. main pipe, 1 in 12-in. main pipe, 1 on 24-in. main pipe, 1 on 30-in. main pipe, 2 on 40-in. steel main, 1 on 63-in. conduit. Five leaks on supplies in street, one on 6-in. main and one on 40-in. main were caused by electrolysis.

Operation of Filter Plant at Bangor, Me.—The new filter plant of Bangor, Me., was placed in operation Feb. 6, 1911. It consisted of six units. In 1912 the plant was increased in capacity by the equipment of two blank units, so that at the present time this plant consists of eight units with a total sand area of 3,407 sq. ft. The minimum capacity of this plant is 8,000,000 gal. per day, but this rate can be greatly exceeded for short periods. The sand in the filters has an effective size of .55 to .59 mm. and a uniformity coefficient of 1.25 to 1.74. At times of extreme cold weather ice has formed in the rear of the beds, under the concrete decks, but this has been overcome by reducing the head of the water on the sand beds, so that air may circulate under the filter decks. In operating the filters during the cold weather, it is necessary to wash them every eight hours otherwise they become "air bound" and permit undesirable water to pass. The "air bound" conditions commence when the temperature of the water is below 45° F. When the water is warmer it is possible to operate the filters from 16 to 24 hours between washings. The average amount of water treated during the municipal year 1915-1916 was about 3,710,000 gal. per day. During the year 4,029 filters were washed, an average of 11 per day. This is a decrease of 3.6 per cent in the number of filter washings. The average amount of water used in washing one filter was about 22,000 gal., the filter being out of service about 6 minutes.

Cement Lined Wrought Iron Galvanized Service Pipe.—The Water Works Department of Lynn, Mass., is now using wrought iron galvanized pipe for services. The department lines the pipe with cement. The cost of the new service pipe is approximately 50 per cent of that of the former pipe. Malleable iron counter sunk fittings lined with lead are used with the new service.

Notes on Maintenance of Wachusetts Aqueduct.—The following notes from the report of the Metropolitan Water and Sewerage Board, Boston, Mass., relate to maintenance work in connection with the Wachusetts Aqueduct: The usual care has been taken of the aqueduct lands and structures and the brush, grass and weeds have been cut. The mowing covered a length of 10 miles and cost about $87 per mile. Wheelock No. 65 wire fence was constructed along the aqueduct land for a length of 13,383 ft., at a cost of 15 ct. per linear foot including 16 iron gates each 10 ft. in length. This fence replaces a spruce board fence which was erected in 1897. About 6¼ acres of aqueduct embankment in Berlin and Northborough were regraded, dressed with fertilizer and sown with grass seed at a cost of $77 per acre. The upper 7 miles of the aqueduct was thoroughly scrubbed on the inside with stiff brooms and clean water in August, at a cost of $43 per mile. This work included the application of a wash of two coats of Portland cement grout containing 2 per cent Medusa waterproofing compound to a length of 25 ft. of the aqueduct, in continuation of the work done last year, to check a slight leakage which continued at this place. Early in the summer the portion of the open channel from the terminal chamber of the masonry aqueduct down to the upper dam was improved along the shore line by removing bunch grass and other vegetation and regrading the slopes with the fine material washed down by the flowing water and facing them with heavy gravel found along the shores. The cost of the work was 3.2 ct. per linear foot of shore line, which is equivalent to a maintenance cost of less than $11 per mile of shore line per year.

Notes on Operation of Filter Plant of Erie, Pa.—The rapid sand filtration plant of Erie, Pa., filtered 6,881,170,000 gal. of water in 1916. Compared with 1915 this is an increase of 1,066,600,000 gal. or 18.34 per cent. At times, especially during the months of July and August, the plant was operated as high as 35 per cent above its normal capacity. While operating above normal capacity no decrease was noted in the high efficiency obtained while operating at normal rates. It required 304,631 lb. of aluminum sulphate to treat all the water filtered; expressed in grains per gallon is equal to .31. This is an increase of 50 per cent over the amount required per gallon in 1915. The increased turbidity of the water treated made the increase in coagulant necessary. Total hypochlorite of calcium used 27,138 lb. or 3.9 lb. per 1,000,000 gal. treated. In washing the filters, 129,100,000 gal. of filtered water were used. This is 1.88 per cent of the total filtered. The cost of operation and maintenance for 1916 was $13,868; cost per 1,000,000 gal. filtered $2.02. Cost of operation and maintenance is divided as follows:

Labor and supervision	$6,739.26
Alum	4,658.89
Hypo	1,045.71
Wash water	1,050.40
Maintenance of plant and laboratories	373.77
	$13,867*

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*Does not include low duty pumping, light, heat or pressure water.

Creosoted Wood Stave Pipe Line for Irrigation Project

A creosoted wood stave pipe line has been constructed recently by the Wenatchee Reclamation District of Wenatchee, Wash., replacing ordinary wood pipe that had outlved its period of usefulness. The pipe line carries irrigation water for the main portion of the Wenatchee Valley, comprising a total of some 12,000 acres, 7,500 acres of which are in Chelan County (immediately surrounding the city of Wenatchee) and the remainder in Douglas County, across the Columbia River. The creosoted section is 1½ miles long, is 63 in. in diameter for a portion of its length, reducing to 60 in. with an increased head.

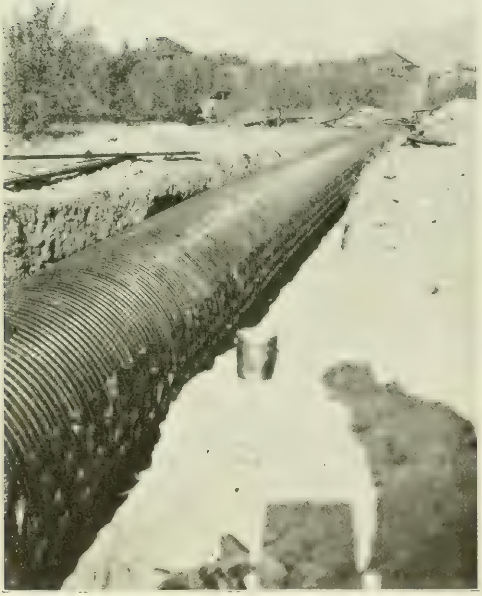


Fig. 1—63-in. Creosoted Wood Stave Pipe Line in Place.

Figure 1 shows the 63-in. creosoted wood stave pipe in place. Fig. 2 is a view showing one leg of an inverted siphon, which is 66 in. in diameter. This one section is 190 ft. long and rises to an elevation of 115 ft. in that distance. Fig. 3 shows the pipe line on bridge crossing the Wenatchee River. Three large gate valves are placed in the pipe line on this bridge by means of which the line is drained.

The staves used in this pipe had a net thickness of 2 in. They were properly kiln dried and milled before receiving the creosote treatment, which consisted of approximately 8 lb. of creosote oil to the cubic foot of timber, or ⅔ lb. to the board foot. This quantity of oil, it is stated, has been found quite sufficient for the proper treatment of this class of material. It is very necessary, however, in carrying on the treatment to see that the wood received the oil without harm to itself.

In the creosoting it was necessary to devise a method whereby a proper treatment of the staves could be accomplished without in any way affecting the size, shape or physical characteristics.

In order to make a satisfactory pipe, the treated staves necessarily should be able to withstand as great band pressure as the untreated wood stave. A series of tests conducted on treated and untreated staves showed that the treated stave had a slightly greater resistance to band pressure than did the untreated stave—the test being made on both specimens after they had been soaked in water for a period of 30 days. This is a very important point, for in assembling this large pipe in the field, the question at once arises as to how tight the bands should be cinched in order to allow for subsequent expansion due to the absorption of moisture by the staves. It was found that the staves when properly treated did not swell nearly as much as the untreated stave, but did swell sufficiently to make a tight pipe.

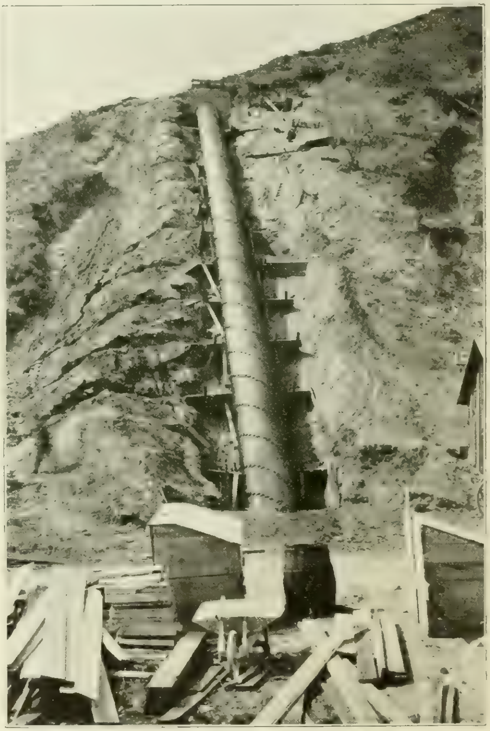


Fig. 2—Inverted Siphon 190 ft. Long Rising 115 ft.

Up to the present time, specifications for Douglas Fir pipe staves have specified heartwood, permitting sap on the inside of the stave and allowing no great depth of the same—usually not to exceed ½ of the thickness of the stave. In examining the treated staves it was found that sapwood portion was thoroughly impregnated with creosote oil and consequently a sapwood pipe stave, when treated, should be as satisfactory as heartwood, from the standpoint of decay. The question of whether or not the sapwood staves would stand the band pressure was immediately brought up. The test referred to above, covered both heartwood and sapwood staves and the results indicate that the treated sapwood stave resisted the band pressure very satisfactorily.

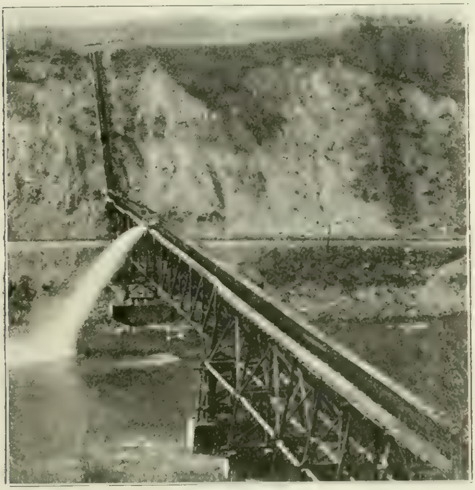


Fig. 3—Pipe Line Crossing Wenatchee River; Gate Valve Open to Drain Line.

The creosoted staves were supplied by the Pacific Creosoting Co., Seattle, Wash.

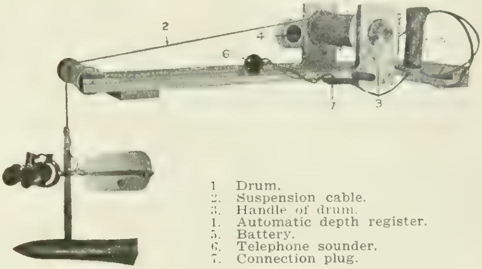
Method of Forcing Pipe Through Embankment

In connection with the construction last year of a sewerage system for the town of Wellesley, Mass., it was necessary to lay a 12-in. sewer under the Cochituate Aqueduct of the Metropolitan Water and Sewerage Board. The aqueduct at this place is built in quite a high embankment and to guard against possible injury to the aqueduct from settlement, the contractor who was laying the sewer for the town was not allowed to carry the trench excavation into the slopes of the embankment beyond the point where the material supporting the aqueduct would stand at the angle of repose, and he was required to securely sheet and brace the excavation. A pipe 24 in. in diameter and 20 ft. in length, made of steel plates 3/8 in. in thickness, was then forced under the aqueduct by using a 35-ton hydraulic jack and excavating the material from the end of the pipe as it was pushed ahead. To keep the pipe on line and grade the portion projecting beyond the embankment was securely held in a timber cradle constructed for the purpose. The time required to force the pipe under the aqueduct was six days, the daily progress varying from 1½ ft. to 4½ ft. The material excavated was fine sand for the lower two-thirds, with gravel filling for the upper one-third. After the 24-in. pipe was forced through a 12-in. cast-iron sewer pipe was laid inside of it and the space between the pipes was filled solid with cement grout under pressure.

Metering Accessories of Manitoba Hydrometric Survey

In connection with its investigations in the Province of Manitoba, the Manitoba Hydrometric Survey has developed several devices for use in gathering stream flow data. These accessories are described in a recently issued progress report of the Survey, from which the following notes are taken:

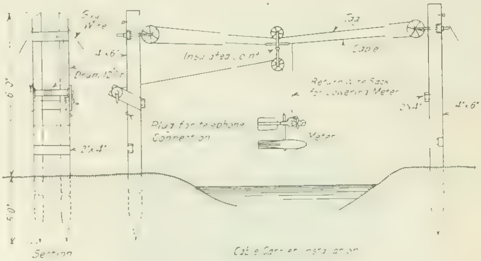
Cable for Suspending Meter.—A number of the metering stations operated are on large streams where depths up to 75 ft. are encountered. Piano wire has been used for suspending the meter, a small insulated wire forming the second side of the circuit. Lately a special steel cable of small diameter with an insulated copper core has been experimented with and has given good results, the advantage over piano wire being less liability to break through kinking and the elimination of the second wire. Where either method of suspension is adopted, a reel is necessary, so that all the stations where considerable depths are encountered are equipped with reels, a special equipment being used for metering at boat stations.



1 Drum.
2. Suspension cable.
3. Handle of drum.
4. Automatic depth register.
5. Battery.
6. Telephone sounder.
7. Connection plug.

Metering Board for Boat Station.

Counting Device for Use with Reels.—A counting device for use with the reels is now in use. The counting part of the device is similar to that used in gas meters. It is connected to the spindle of the reel by a train of gears, the counter and gears being enclosed in a metal case. Through the connection, each revolution or part of a revolution of the reel or drum is recorded on the dial of the counter. By turning in one direction the revolutions are added and by reversing the direction they are subtracted. The counter may readily be thrown out of gear and the dial reading brought to zero. By using a reel exactly 1 ft. in circumference and setting the dial to read zero when the meter is at the surface of the water any position with reference to the surface of the water is automatically registered on the dial. The


Guy Wire
4"x6"
Drum 12"
Insulated Joint
Guy
Cable
Return Line Back for Lowering Meter
2"x4"
4"x6"
Plug for telephone Connection
Meter
2"x4"
6'3"
5'0"
Section
Cable Carrier Installation

Details of Cable Carrier Station.

counting device may be detached from the reel by loosening three thumb screws; they are interchangeable so that one may be carried by each field engineer and used with any reel.

Metering Board.—The Nelson and the Saskatchewan are two of the largest rivers metered; on each of these there are boat stations. The velocities being high, it has been found that a canoe does not afford a steady enough working platform. The method now employed is to secure two canoes together parallel to one another by means of three pieces of oak laid across the gunwhales and bolted to the thwarts at each end, thus forming a kind of catamaran; a bridle is then fastened to the bows of the canoes and a line led from the center of this bridle to the tag line stretched across the river. The meter may be suspended between the canoes or over either side by means of the metering board used on boat sections. The board has been modified to permit of its use with the counting device, described in the previous paragraph. This modified form of the metering board is illustrated.

In making soundings at stations where considerable depths are encountered, much difficulty is always experienced in determining within close limits when the bottom is reached by the sounding weights. An attachment has been devised for use with the meter bar in sounding, the meter being removed in such case. By means of the device an electrical contact is made when the weight reaches the bottom, the contact being announced in the ear piece the same as when metering. The installation is shown in the illustration of the metering board. Good results have been obtained with this device, especially when used in sounding the larger streams, and also at the cable carrier stations where the sag in the cable span formerly influenced the results.

Cable Carrier Stations.—The accompanying drawing shows some details of the new cable carrier stations installed by the Survey.

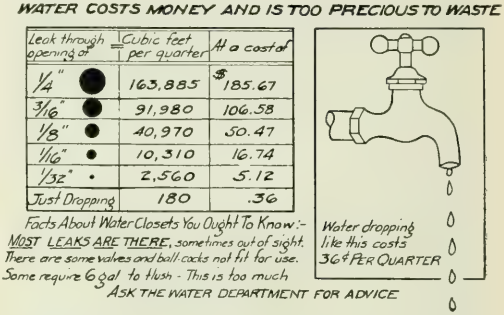
Standardized Top for Meter Housings

A cover and locking device for a meter box or housing, embodying a number of practical features, has been placed in production by the Modern Iron Works, Quincy, Ill. The top has a rectangular throat. It is equipped with an automatic quick opening lock. The top part of the locking device is galvanized malleable iron and the bottom part which comes in contact with the iron casing is bronze. To unlock the key is given a one-half turn and the cover raises about ½ in., and stays open until relocked. With a view to increasing the efficiency of meter installations as well as to reduce the manufacturing costs the Modern Iron Works has stanardized upon one size of cover, made to fit a tile measuring 18 in. in inside diameter.

Modern Top for Meter Housings.

Educating the Public on Reducing Water Waste

The Water Department of Waltham, Mass., employs the cards illustrated below as a means for educating the water users in reducing waste. The card is sent to consumers when their meter readings show excessive consumption. The front half of the card bears the following notice:



WATER COSTS MONEY AND IS TOO PRECIOUS TO WASTE

Leak through opening of		= Cubic feet per quarter	At a cost of
¼"	●	163,885	$185.67
3/16"	●	91,980	106.58
⅛"	●	40,970	50.47
1/16"	•	10,310	16.74
1/32"	·	2,560	5.12
Just Dropping		180	.36

Facts About Water Closets You Ought To Know:-
MOST LEAKS ARE THERE, sometimes out of sight.
There are some valves and ball-cocks not fit for use.
Some require 6 gal to flush - This is too much

Water dropping like this costs 36¢ PER QUARTER

ASK THE WATER DEPARTMENT FOR ADVICE

Postal Card Used by Waltham, Mass., Water Department.

WALTHAM WATER DEPARTMENT.

........................191..

At ....St., the meter shows an excessive consumption of water. As we are compelled to charge for all water registered by the meter, this ought to have your immediate attention. This notice is not obligatory on our part, but indicates a desire to co-operate with you in stopping an apparently needless expense.

.... Supt.

Bertram Brewer is Superintendent of Water Works of Waltham.

Contractors for 16 National Cantonments

Contracts for the 16 cantonments to be erected for the new National army have now been awarded. This work, involving an expenditure of nearly $100,000,000, provides for the construction of 16 cities each having housing and sanitary facilities for approximately 40,000 men. The location of the contonments and names of the contractor follow:

Location of Cantonment and Contractor.
Little Rock, Ark.—James Stewart & Co., New York.
Atlanta, Ga.—Arthur Tufts, Atlanta.
Rockford, Ill.—Bates & Rogers, Construction Co., Chicago.
Des Moines, Ia.—Charles Weitz & Sons, Des Moines.
Fort Riley, Kan.—Geo. A. Fuller, New York.
Louisville, Ky.—Mason & Hanger, Lexington, Ky.
Annapolis Junction, Md.—Smith, Hauser & MacIsaac, New York.
Ayer, Mass.—Fred T. Ley & Co., Springfield, Mass.
Battle Creek, Mich.—Porter Bros., Portland, Ore.
Wrightstown, N. J.—Irwin & Leighton, Philadelphia.
Yaphank, N. Y.—Thompson-Starritt Co., New York.
Chillicothe, O.—A. Bentley Sons Co., Toledo, O.
Columbia, S. C.—Hardaway Contracting Co., Columbus, Ga.
Fort Sam Houston, Tex.—Stone & Webster Eng. Corp., Boston, Mass.
Petersburg, Va.—Rinehart & Dennis, Charlottesville, Va.
American Lake, Wash.—Hurley & Mason, Tacoma, Wash.

Personals

E. R. Gray has been appointed city engineer of Hamilton, Ont.

W. H. Schwartz has been appointed city engineer of Vancouver, Wash.

John P. Kelly, formerly of Kelly & Wheeler, contractors, Buffalo, N. Y., has organized the Kelly Engineering Corporation, with headquarters at Buffalo.

William M. Kinney, engineer of the promotion bureau and inspecting engineer of the inspection bureau of the Universal Portland Cement Co., Chicago, has been elected to the executive committee of the American Society for Testing Materials.

M. A. Berns, publicity representative, Universal Portland Cement Co., Chicago, has been commissioned a captain in the Engineers' Section of the Officers' Reserve Corps and expects soon to be ordered to the second training camp. Mr. Berns is a civil engineering graduate of the University of Illinois.

H. G. McCormick, for the past five years in charge of lock and dam construction on the Kentucky River for the Federal Government, has resigned as U. S. Assistant Engineer and has entered the contracting business under the firm name of Shipplett-McCormick Co., Inc. The firm will specialize in heavy concrete work.

Dirt Mover and Pit Owner Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.*
W. H. FOGERTY, *General Manager.*

First Wednesday Each Month. ....Roads and Streets... $1 Yearly
Second Wednesday Each Month....Waterworks and Hydraulics .. $1 Yearly
Third Wednesday Each Month......Dirt Mover and Pit Owner....$1 Yearly
Any Two or More Monthly Issues, 75 Cents Each Per Year.
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Fifth Wednesday..............Price and Market Quarterly... 25 cts. Yearly
Every Wednesday ....$3 Yearly
Contract News Appears in All Issues

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When Will Railway Presidents Learn How to Handle a Rate Case

Again a great railway rate case has been lost. "The captains and kings depart," but "the tumult and shouting" do not "die," in fact the noise has only fairly begun, for it has come to be characteristic of railway officials to damn the decisions and berate the deciders.

Will railway presidents ever learn? Will some of them, some day, go to the presidents of electric and telephone companies to inquire why it is that they win rate cases fully as often as they lose them? When they do, there may come a turn in the tide of railway prosperity.

Prof. Pupin, of Columbia, recently said in a speech that he believed the two most efficient organizations on earth are the British navy and the American Telephone and Telegraph Co.—the parent of the Bell telephone system. Has anyone ever heard of President Vail of the A. T. & T. utter such sentiments as those that have characterized President Loree of the D. & H. R. R. Co.? Why not? Is it because the telephone companies usually win their cases and are prosperous, whereas the railway companies almost invariably lose and are not so prosperous? Read the following letter to the Philadelphia Public Ledger:

> To the Editor of Public Ledger:
>
> One-third of the productive investment capital of the country is invested in steam transportation, traction lines, express companies, electric light and power, gas and water companies and other utilities subject to public service commissions, Federal and State. These commissions all have repressive but not regulatory powers. In a condition of unexampled prosperity these utility corporations are poverty stricken.
>
> This condition constitutes an indictment against the commission form of government that it seems to me will take a lot of explaining by the commissions.
>
> Does not the lack of vision indicated by the Interstate Commerce Commission in this rate case point to underlying defects of commission government? L. F. LOREE,
>
> President Delaware & Hudson Railroad Company.
>
> New York, July 2.

Mr. Loree calls the public service commissions "repressive but not regulatory." He might profit by studying Theodore Vail's annual reports in which he regards the regulatory powers of commission as salutory and necessary. And if Mr. Loree would look carefully through one of the recent reports on the Bell telephone system, he would perhaps be struck by two facts: First, that appraisals of all Bell telephone property have been made and that they show an appraised value of physical property in excess of the stock and bonds. Second, that a large depreciation reserve has been built up out of earnings.

When a Bell telephone company "goes to the mat" in a rate case, it does so in quite a different fashion from that hitherto seen in every great railway rate case. First, it proves the cost of reproducing its property. Next it shows that past experience, based on actual records and not on mere opinions, demonstrates the necessity of providing a depreciation annuity of about 6 per cent on the plant cost, in addition to more than 4 per cent for "current maintenance." Contrast this procedure with that in every great railway rate case. Appraisals by disinterested engineers are never presented by the railways. If any appraisals are presented, they are by engineers regularly in the employ of the railways; but usually there is no appraisal presented. As typified in the recent case, the commission is deluged with a testimonial lava of mingled fact and fancy. Figures there are till you can't see through them, but not a single set of figures to establish the basic fact, the fact that every rate commission seeks first, namely, the actual investment in the physical property, or, in lack of that, its cost of reproduction.

Samuel Rhea, president of the Pennsylvania Railroad, also has just written to a daily paper, and he says:

> I would like to ask if there is any more important interest in the great State of Pennsylvania than its railroads, and if you think any other interest could live under the present intolerable and agglomerated regulation and price fixing to which it must submit? All suggestions of taking over coal mines, shipyards, etc., by the Government or the output of same, on any percentage contract, seem to agree in allowing the owners at least 6 per cent on the cash invested in the property, the cost of depreciation, depletion in case of mines, etc., and a profit. And yet the commission seems to regard as sufficient its estimate, for the year ending June 30, 1917, of a return of 4.89 per cent on road and equipment provided for public use by the eastern railroads, out of which they must pay their interest on borrowed money, dividends on money invested by holders of stock, provide a margin for lean years and buttress their credit.

And other railway presidents are appealing to the public on the same ground, namely, that the Interstate Commerce Commission has "conceded" that the railways are earning less than 5 per cent on their "investment." Yet, as a matter of fact, the commission used quite another term than "investment," and it means quite a different thing. The term the commission used in its recent decision is "book value." The book or ledger value of railway property is usually not the investment cost. Commissions regard "book values" with great suspicion, particularly when not given in such detail that each item in the books can be at least roughly checked against an existing physical thing. In short, a commission believes that "book values" usually contain "intangible values" which may or may not be justified, and they properly put the burden of proof on the company. Railway companies have notoriously avoided proving either the actual cost of their plant or its cost of reproduction; and in this last rate case they made no pretence of proving either. Instead, they dwelt mainly on the rising costs of operating their roads, and so laid themselves wide open to the very "comeback" that the commission used in its decision when it pointed out that the rising income nearly offsets the rising expenses.

Had the railways followed closely the methods of the most successful telephone and electric companies in presenting their cases, there would have been a different result. Instead of dwaddling along with the appraisals of their properties, the railways would have rushed through an appraisal, which could have been finished long ago. A good appraisal can be made in 18 months for the biggest utility or railway plan that exists. For example, with a staff of about 600 men, an appraisal of more than $200,000,000 of telephone plant was made in a little more than a year. Also an appraisal of an even greater amount of railway property was made in a year. The writer is now speaking from his own experience. But, on the other hand, by employing a relatively small staff and by infinite hairsplitting, it is possible to prolong an appraisal job for five or ten years, which is substantially what the railways are now doing.

We suggest that some of the railway presidents who are talking the loudest would find it more advantageous to study what other utility companies have done to expedite inventorying and valuing their plants. Likewise they may profit from a careful study of the depreciation annuities that many public utility companies, other than railways, set aside.

It was only a few years ago that a test case had to be fought to compel a railway company to abide by a ruling of the I. C. C. as to depreciation reserves for rolling stock. Instead of seizing that first life preserver that the commission threw to them, the railways contemptuously kicked it away, and have kept on kicking it away. Those who are now so loudly denouncing the commission had better not be so sure that they are the injured innocents.

It is the writer's belief that half of the 15 per cent advance in freight rates that was sought could have been justified as necessary to provide an adequate depreciation fund. But the mere opinion of the oldest of railway men will not suffice to establish such a fact. There is needed a sort of engineering analysis of this problem that has never yet been presented to any commission in a railway case, although the same sort of analysis has frequently appeared in telephone and electric cases.

Rate cases are not to be won by the testimony of presidents of railway companies, nor by the skilled arguments of attorneys, but by cost analyses made by unbiased engineers who, having mastered both the accounting and the engineering details, present incontrovertible evidence from the records of the railways themselves.

When will some railway president depart from precedent and go to the presidents of a few successful telephone and electric companies for counsel? Judging from the uniformity with which railway rate cases are botched, it would seem that advice is sorely needed from some external source. Doubtless, however, the official "inbreeding" of which railway presidents have so long boasted will continue to make them believe that no one can ever enlighten a railway man in the management of railway affairs. And doubtless each successive defeat in a rate battle will not prompt any introspection, but will merely strengthen the conviction of railway officials that every railroad commission either "lacks vision" or is "playing politics."

Wasted Waterpower and Why

Secretary Lane recently stated that there are 35,000,000 horsepower of undeveloped water power in America. Hence one-third of a horsepower per capita is being wasted. Why? Is it because it is cheaper to develop power by steam? The writer has appraised more than a score of hydro-electric properties, and, with only one exception, the hydro-electric plants were more economic than steam, even when fuel was much less expensive than it now is. There are unquestionably hundreds of large water powers that can be economically developed, but capitalists hesitate to put their money into them. Why?

About 15 years ago a small group of self-styled patriots—Pinchot, La Follette, and others—set up the cry that capitalists were seizing all available water power sites, and that if the government did not put a stop to this exploitation the public would be compelled to pay tribute forever. As a result, the federal government, acting through its forestry bureau, began to withhold permits for water power developments, except under conditions that business men hesitated to accept. Then came the decisions of several state public service commissions in which only 8 per cent "fair return" was allowed on the actual investment in hydro-electric plans. The courts have frequently ruled that water rights have a value in addition to the value of the water power plants, but the public service commissions have managed, one way or another, to give little or no recognition to any such value in excess of the actual cost of acquiring the water rights.

As a result of the acts of the federal government and the decisions of state public service commissions, there is a condition that investors in water power properties regard as unattractive. They feel that if a water power project becomes a financial success, they will be limited to 8 per cent on the investment, whereas if it turns out to be an economic failure they themselves will have to stand the entire loss.

The risks incident to the development of a hydro-electric property are evidently regarded by public service commissions as being much smaller than investors believe them to be. Perhaps the commissions are right, but we do not recall ever reading a commission decision that indicated that a painstakingly thorough study had been made of this element of risk in relation to water power development. Even granting that the commissions are right, they seem to forget that the investor, if unconvinced, is like the horse led to the watering trough from which he refuses to drink.

In a recent article in the Electrical World, Mr. Hugh L. Cooper estimates that if the wasted 35,000,000 horsepower of water power were developed the country would be $1,241,600,000 the gainer every year, or nearly $36 per horsepower. Mr. Cooper has made a serious error in his assumptions, for if we capitalize the $36 at 10 per cent we get $360 as the value of each horse-power of water rights, which is certainly from four to ten times too great. Nevertheless, it is incontestable that a vast sum is annually going to waste because of injudicious government action, both state and federal, the latter through a restrictive and narrow policy of so-called "conservation," the former through failure to be liberal enough in the rate-making policies.

There are many well meaning political office holders who, in their zeal to save a dime for their great grandchildren, deprive their children of a dollar. They are the kind of "economists" who throw the spotlight on the debit side of the public ledger, and look on the credit side only by star-light.

The Decision of the I. C. C. in the Freight Rate Case

The Interstate Commerce Commission has rendered a decision in the rate case in which all the railways had asked a 15 per cent increase in freight rates. The western railways are denied any increase. The southern roads are given higher rates on coal and iron ore. The eastern railways are granted increased class rates only, which may prove to be equivalent to an average 8 per cent increase in all freight income.

This rate case was the outgrowth of the 8-hour day for train operators, which was forced upon the railways by Congress last fall. Judging by the editorial comment of the great majority of newspapers, the public favored granting an increase in freight rates to all railways, but Commissioner Harlan was the only one of the six commissioners who favored giving the railways substantially what they asked.

The other commissioners held that since the net earnings for 1917 seem likely to be a larger percentage on the "book value" of the railway properties than in any recent year except 1916, the railways have little to complain about, even though wages and prices have risen considerably; but that, since the eastern railways seem to have suffered most from increased operating expenses, and may suffer still more, some relief should be given to them.

Commissioner Harlan, however, regards this attitude of his associates as regrettable. He contends that for many years there has been insufficient capital invested in railways, mainly because the investing public is dissatisfied with the returns from their railway investments. Commissioner Harlan has diagnosed the case correctly. The real question is not whether the year 1917 will show a percentage of net earnings in excess, say, of the average of the five preceding years, but whether the investing public will buy the new stocks of railways that propose to enlarge their terminals, double track their lines and build new branches. To this feature of the case, which outstrips every other feature in importance, the five other commissioners apparently gave scant consideration.

The "book value" of the railways is $74,500 per mile, and upon this value the commission estimates that the net earnings for the first four months of 1917 were 1.939 per cent, at which rate the calendar year of 1917 will show 5.817 per cent. The following are the corresponding percentages for the nine preceding years:

1917	5.817
1916	6.400
1915	5.240
1914	4.091
1913	4.683
1912	5.300
1911	5.070
1910	5.519
1909	5.866
1908	4.941

It will be noted that the average percentage for the 8 years prior to 1916 is less than 5.1 per cent on the "book value." Unfortunately, the "book value," or "ledger value," does not mean the actual investment in the railway plant. What the investment really is no one knows. The appraisals now in progress are intended to throw light on this matter. Commissioners are inclined to regard "book values" as being considerably in excess of actual investments, whereas railway officials contend that the reverse is true. Hence the percentages above tabulated mean nothing save for purposes of comparing one year with another.

It is generally conceded that for the last 10 years railway construction has not kept pace with the growth of the country, and that this is attributable to the small return on railway investments. Obviously, then, the present (1917) rate of return will scarcely attract capital, for it is higher than normal solely as a result of a war that may end any day.

As stated in another editorial, we believe the railways botched their case, because they based it on increased operating expenses due to the war and to the 8-hour law, thus virtually challenging the commission to look at the other side of the ledger where it was only too evident that earnings had risen faster than expenses. The real rate case remains to be fought out along the lines indicated in the accompanying editorial.

The Increasing Use of Large Drills Mounted on a Wagon or Car

In the 1916 edition of Gillette's "Handbook of Rock Excavation," comment is made upon the growing tendency to use very large drills where the surface of the rock is comparatively level and the holes comparatively deep. A level surface permits mounting the drilling outfit on wheels, enabling the drill to be moved speedily from hole to hole.

It has not been regarded as economic to use large drills (with 5-in. cylinders, such as are designed for subaqueous drilling) in drilling shallow holes or where the surface of the rock is very irregular. But the recent economic success of such drills in deepening the channel of the Mississippi at Le Clair, Iowa, known as the Le Clair Canal, seems to warrant serious consideration of large drills even for shallow holes and where the rock surface is rough. This work involves making a rock cut nowhere more than 5 ft. deep, in an unusually "spongy" limestone full of holes and having an uneven surface. Air hammer drills (Jackhamers) were tried at first, but crumbling rock clogged the bits, even when water jets were used, to such an extent that they were abandoned.

The problem was solved by mounting two Ingersoll-Rand slab-back drills on a flat car. The mounting is somewhat similar to that on a drill boat. Each drill is mounted in a sort of pile-driver frame, so that it can be raised and lowered with a hoisting engine, and the frame can be moved laterally along a runway, this being 30 ft. long for the two drills. The flat car that carries the drills, boilers, etc., travels on track sections, 10 ft. long, like a steam shovel. Each drill has averaged 110 ft. per 8-hour shift. A water jet was used to good advantage.

The solving of this problem of drilling economically in a very bad rock is highly creditable to the engineers in charge—Maj. G. M. Hoffman, Corps of Engineers, U. S. A., J. B. Bassett and H. E. Reeves, assistant engineers. The question that we now raise is whether a drill-car outfit of this kind is not adapted for shallow drilling even where the rock is sound. If 110 ft. per drill can be daily averaged under bad conditions, it is evident that considerably more can be averaged under ordinary conditions. Probably in solid rock and for shallow holes a smaller size of drill would serve, and in that case, it might be feasible to use runways longer than 30 ft., and perhaps provide a runway at each end of the drill car so that four or maybe six drills could work simultaneously.

Goethals Adopts "Cost Plus" Contract for Ship Yards

Gen. Goethals, who is in charge of the federal ship building, has just announced that contracts will be let this week for two ship building plants to produce 400 steel ships within the next 18 months. The ships will average about 6,250 tons each. He says:

> For the building of these two yards and the construction of ships in them I shall offer compensation to the agents who undertake the work, a fee of approximately 6 per cent of the total cost of the work, with rewards for savings on cost and for speed in delivery. Provision will be made for decreasing the fee to prevent unnecessary cost. The contracts will give the Government the benefit of Government fixed commodity prices and will provide for cessation of work at any time so that the appropriation may not be exceeded. Options will be given to the contractors to purchase the plants at arbitrated values on the completion of the work.
>
> The design of the ship is ready, the plans of the yards are ready, the distribution of the work of furnishing the material and of fabrication is arranged.

To civil engineers and contractors generally there is more than ordinary significance in this decision to adopt a cost plus a contingency fee contract for government work. We have repeatedly urged the advisability of making the contractor's fee dependent in large measure upon the economy with which he handles the work. We are now glad to see that this form of contract is to be used on government work on a large scale.

The Nomadic "Hobo:" Can He Be Made to "Stay Put?"

The "hobo" laborer has long been the despair of all those in charge of construction work in the west. The "hobo's" main object in life is to secure a sufficient "stake" to enable him to go on a spree of about a week's duration. If his "stake" will not sustain so long a stretch of elysian delight, then he contents himself with a three-day "jag" instead of a seven-day "jamboree."

Usually this type of laborer is quite intelligent and often a very hard worker—while at work—but he will not "stay put." His fancy paints a picture that soon lures him away from his industry, and then he asks for his "time." If this is refused, he soon manages to get "fired" for carelessness or inaction, and he goes off happy in the prospect of a change that will speedily leave him with no "change." Such is the kingdom of "hoboism."

It has been suggested by certain contractors that if railway companies would exercise more vigilance as to the passengers who use the "side-door pullmans" and the no-door brake-beams, the life of the "hobo" when on the road could be made so irksome that he would sooner work than travel. Beside the difficulty of teaching countless trainmen not to "graft"—for even a "hobo" pays to jump a freight—there is the much greater difficulty of changing the taste of these nomads of the tie and rail.

We are reasonably sure that a Victrola and a truck load of "ukes," "rags," "Sousas," and "gold seals" will not keep the "hobo" in camp, for we have tried it, and the canned music seemed rather to whet his appetite for the fresh stuff downtown. At any rate, the average stay of five days in our Hotel de Beau suddenly dropped to three days after we bought the phonograph and turned it loose among the guests of our hotel. The boys expressed great satisfaction over the entertainment each evening, but came around in growing numbers every morning after breakfast complaining of severe pains, shooting pains that shifted their entrenchments rapidly, so rapidly in fact that the "hobo" whose "stomach was on the blink" at 6:45 a. m. had acquired a "sprained ankle" at 7:30 and wanted to ride to town in the engineer's Ford.

No, we shall remain skeptical as to every proposed agency for changing a "hobo's" tastes, save that of the stark recruiting officer with the scythe who enlists him at last in those horizontal ranks whence none desert.

What Does It Cost to Educate an Engineer?

When Columbia University had a four-year course in mining engineering, it cost the university $2,700 to train each student, exclusive of interest on the buildings and plant, and exclusive of the student's board and other living expenses which probably averaged about $2,400 for the four-year course. Now that the course is six years long the university expends about $5,400 per student, or double what it did formerly; the higher cost per student being as much due to the falling off in number of students as to the lengthening of the course.

It would be very interesting to know what are the costs of training engineers at college, inclusive of interest and depreciation on the educational plant. If, for example, such a cost were shown to be $5,000, and if the student is required to pay less than $1,000 for his tuition, each graduate owes a debt of $4,000 to society for his engineering training.

The freshman class at Annapolis will be 800 this fall, it is said, which indicates that the free naval engineering training offered by Uncle Sam is becoming increasingly popular. Perhaps if more young men realized the extent to which civil engineering students are public beneficiaries there would be a more general eagerness to study engineering. And, speaking of this, what are the engineering colleges doing to secure a normal attendance next year?

Noiseless Blasting

Although Maxim has not yet invented a "silencer" for use by those engaged in blasting rock, it is possible to split rocks noiselessly. This can be done in several ways, one of which was described in our issue of June 20, whereby an oil burning torch was used to crack boulders. Another method consists in drilling holes about 2½ or 3 ins. in diameter, and filling them with small lumps of freshly slaked lime. The drill hole is filled a foot at a time and water poured in to fill the voids, then another foot of lime and more water, and so on up to within the upper sixth of the hole. The top part of the hole is then filled with tamping, well rammed. In less than a quarter of an hour the rock begins to crack.

The holes must be speedily loaded and workmen must remain away from them, for the tamping is occasionally blown out with a great deal of force.

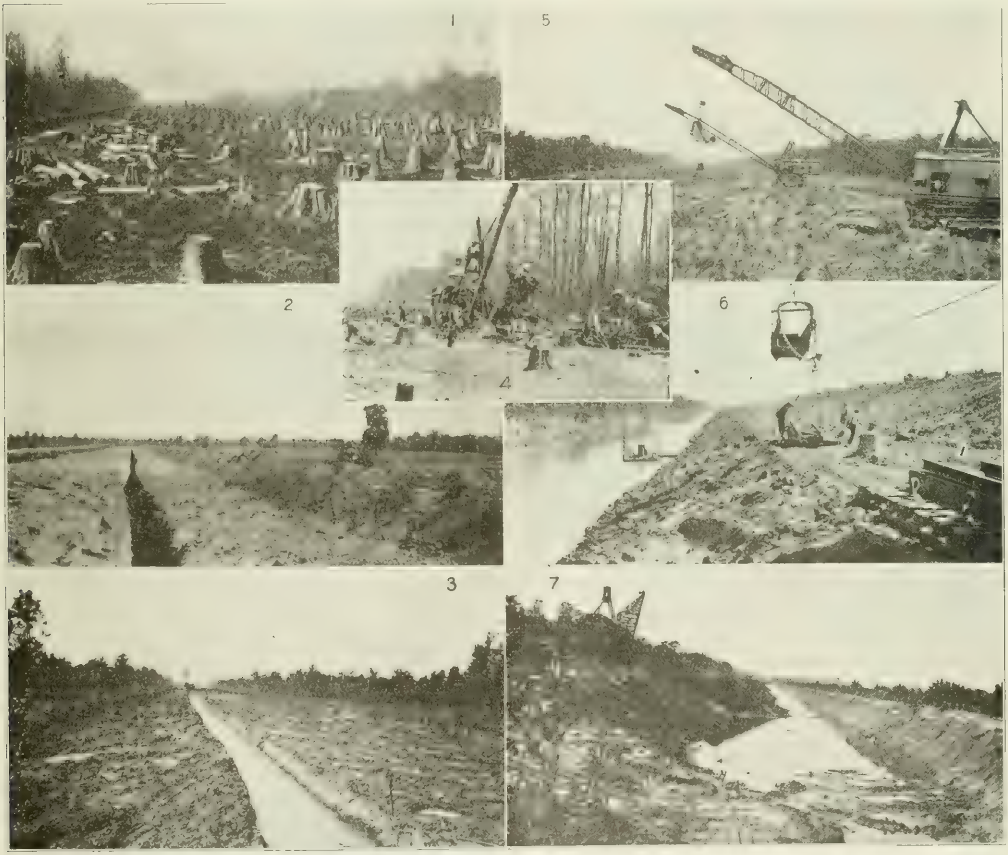
Building and machinery foundations may be removed in this manner without endangering nearby structures.

Construction Methods and Machinery for Headwater Diversion System of Little River Drainage District

By B. F. BURNS

Office Engineer Little River Drainage District.

The task of moving 8,000,000 cu. yd. of earth and clearing 3,900 acres of heavily timbered land, in excavating the 48 miles of large canals and borrow pits and constructing 43 miles of huge levees and preparing the great floodway for the Headwater Diversion System of the Little River Drainage District of Cape Girardeau, Mo., to carry the headwaters into the Mississippi River, was the job that confronted the contractors upon signing the contracts for that work.



Construction Views on Headwater Diversion System of Little River Drainage District, Cape Girardeau, Mo.

(1) Clearing for Channel and Levee; Stump Puller in Background. (2) Showing Stripping and Muck Ditch Excavation Spoiled Along Levee Toe Line. (3) Levee Base Preparation and Muck Ditch. (4) Stump Puller in Operation. (5) Caterpillar and Two Electrically Operated Main Machines Close Together After Making Railroad Crossing. (6) Transformer Barge. (7) Showing Method of Excavation and With Second Machine Making Final Cut.

The work is divided into two contracts, Contract "A" including that part from Allenville west and Contract "B" that part east of Allenville.

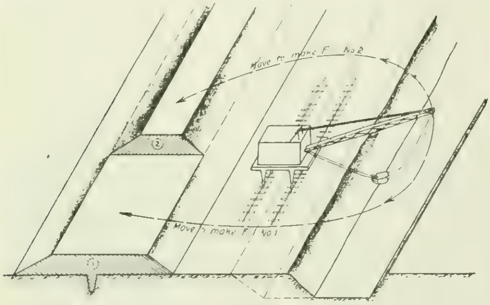
After deciding to begin at the east end of each contract and work westward, the matter of plant was the next consideration. On the main work Bucyrus drag line excavators are being used exclusively and on the Ramsey Creek Diversion Channel a Monighan drag line and a small Lidgerwood machine are being used. In addition to the main excavating machines small Bucyrus caterpillar tractors for striping and digging muck ditches are used.

All of the main Bucyrus machines, with one exception, are operated by electricity. A high tension line carrying 13,200 volts is strung along the channel. This current is generated at Cape Girardeau and is stepped down to 440 volts by transformers at the machines. On the work east of Allenville the transformers are located on barges floating in the channel. This facilitates their movement as the work progresses.

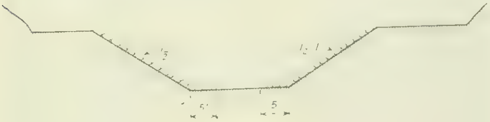
For the main diversion channel and levee a strip is cleared approximately 400 ft. wide. From this, all brush, logs and debris have to be removed. The stumps on the berms must be cut to 24 in. above the ground, but elsewhere they can be cut to such height as will enable them to be removed with stump pullers, stump pullers and skidders being a necessary part of the contractor's equipment. As the work goes forward the floodway strip, 900 ft. in width, is cleared and, before the final completion of the system, all logs, brush and debris will be removed from it so as to permit of the free movement of the flood water over it.

Following the clearing of the channel and levee base area the stumps are broken with dynamite and removed and the roots grubbed out so that the material will be practically free from fibrous matter when excavated from the channel and placed in the levee.

The operation of stripping and digging muck ditch is next in order. On Contract "B," this is done by one of the caterpillar tractors having a boom length of 70 ft. and a bucket capacity of 1½ yd. The machine works over the channel area for a stretch of approximately 2,000 ft., removing the surface material for a depth of 6 in. or more, and depositing the same on the levee area at the limit of its boom reach. It then tracks back and begins stripping the levee base area, removing the surface material to about the same depth as on the channel, and placing the stripping outside of the levee base area and also removing that taken from the channel, which it places with the levee stripping. As the machine moves over the levee base area it excavates the muck ditch, 6 ft. wide and 8 ft. deep, and places that material along the outer toe line of the levee. As the levee is finished, the stripping, which is quite free from roots and other material objectionable for levee construction, will be shaped into a banquette of such height and with such crown as the material will make.



Movement of Excavating Machines in Constructing Levees.



Riprap Slope Paving, Crooked Creek Improvement.

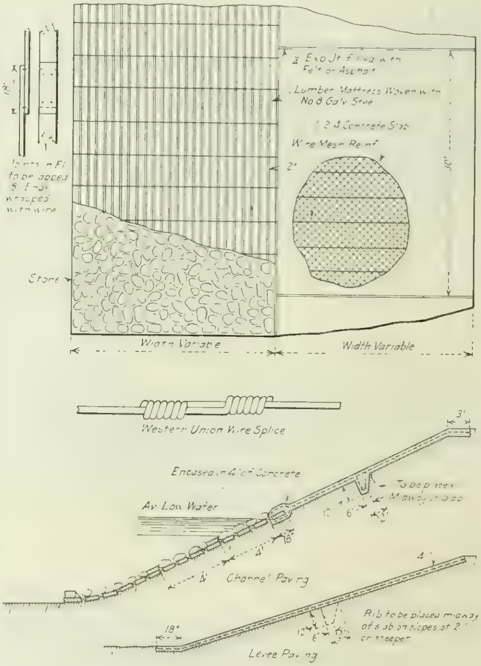
An experiment in the use of dynamite for the excavation of muck ditches was made soon after the construction started. The muck ditch at that point was but 3 ft. by 4 ft. The experiment was not successful as the ditch was unsatisfactory.

The character of the soil under the levees was determined by borings made to a depth of 11 ft., along the center line, at intervals of 300 ft. These borings indicated that at one point the soil was such that an ordinary muck ditch would not effectually cut off seepage. Further investigation showed the extent of that condition to but little more than 100 ft., along the center line of the levee, and, in lieu of a muck ditch, a wall of Wakefield sheet piling was driven. These were driven to a penetration below the sandy strata and allowed to protrude 4 ft. above the surface, penetrating the levee to that extent.

Two machines are required to excavate the main diversion channel.

On Contract "B," the first machine is a Bucyrus drag line, having a 125-ft. boom and a 3½-yd. bucket. This machine tracks along the channel near the center line and excavates approximately 65 per cent of the material. This it places over the levee area in layers about 8 ft. in depth, making two lifts. In depositing the material for the first lift, the movement is clockwise and in placing the second lift it moves in the opposite direction. The earth is compacted by dropping at least 8 ft.

The second machine, a Bucyrus drag line, 100 ft. boom, 4-yd. bucket, tracks along the berm and removes the remainder of the material in the channel. It likewise deposits the material in two lifts and operates in the same manner as machine 1. Usually machines 1 and 2 are at least 2,000 ft. apart. Machine 2 carries the levee to its shrinkage grade and section.


Joints in Fl to be lapped 3' Ends wrapped with wire
Stone
Exp Jt filled with Felt or Asphalt
Lumber Mattress Woven with No 8 Galv Stee
1:2:4 Concrete Slab
Wire Mesh Reinf
2"
30'
Width Variable
Width Variable
Western Union Wire Splice
3'
Encased in 4" of Concrete
Av Low Water
To be placed Midway in Slab
18"
4'
4'
Channel Paving
4"
18"
Rib to be placed midway of slab on slopes of 2 : 1 or steeper
12"
6"
Levee Paving

Details of Bank and Levee Protection Work.

The operations on Contract "A" are similar to those on Contract "B," with the exception that the stripping is removed and muck ditch excavation is made by the pilot machine, which also excavates about 30 per cent of the channel. Two Bucyrus drag lines, 100-ft. booms, 3½-yd. buckets, are in use on this contract.

The material handles more easily if there is some water in the channel, but, if there is too much, it makes the material unstable for levee building and slides result. Except during periods of heavy rain, the stage in the channel is controlled by pumping, dams being left in the channel at intervals and the water pumped from the sections where operations are in progress.

The crew of a drag line excavator, electrically operated, consists of the runners, who work in 8-hour shifts, a foreman, three laborers, a helper and a spotter, who work 12 hours. The machines operate during the entire 24-hour period.

The following statement covering the operations of the contractor for one year is of interest:

Total yardage, four electric machines	2,682,330 cu yd.
Total yardage, three steam machines, including stripping and muck ditch	980,750 cu. yd.
Current consumed during year	1,952,240 K. W. H.
Coal consumed during year	4,350 tons
Grubbing during year	155 acres
Dynamite used during year	133,000 lbs.
Average number of men employed, contract "A,"	102 men.
Average number of men employed, contract "B,"	187 men.

The above indicates that under similar operating conditions it requires 0.756 K.W.H. per cubic yard to move dirt and that 0.9 lb. of coal is required for the same purpose.

At all points where the channel slope or levee face may be subject to attack by current or eddies they will be protected.

On the Crooked Creek Improvement, just east of the east end of the West Basin, channel paving is in progress. Rip-rap is being used, the stones weighing between 50 and 150 lb. each. The entire slope is paved and the paving extends into the channel 5 ft. from the toe of each slope. The paving is done entirely by hand.

On the work east of Allenville there are several points where paving is required and there reinforced concrete is being used for facing the levee and for the channel slope, above mean low water. Below mean low water, a wooden facine mattress, weighted with heavy stone, will be used.

The estimated cost of the entire Headwater Diversion System is $1,345,000, for construction alone. The work is under the direction of Mr. Wm. A. O'Brien, chief engineer, and Mr. Isham Randolph, Chicago, Ill., is consulting engineer.

Movable Incline for Wagon Dumping

The movable incline illustrated below has been used with good results in depositing the surplus excavation from the Evanston intercepting sewer of the Sanitary District of Chicago. This excavation, amounting to over 75,000 cu. yd., is being placed along the lake front at Evanston, inside the proposed shore line of a park. The teams are driven up the incline, a snatch team assisting up the 12 per cent grade, and the waste earth dumped through a trap door at the top. An inclined chute leads from this trap door towards the lake. The material is deposited very uniformly. The entire incline is mounted on house rollers and is moved in either direction by a winch located on the lower frame of the incline and having a wire cable attached to a dead man.

Traveling Incline for Depositing Waste Earth.

Dragline Solves Problem of Digging Gravel from Wet Pit

A useful application of the dragline cableway method in further developing a pit from which all the material above the water-line had previously been excavated, is found at the sand and gravel washery of the Dayton Gravel & Sand Co. at Dayton, O.

Operation of a steam shovel for two seasons had practically exhausted the company's pit to the water-line and when work was commenced this season the company had to choose between two propositions: To lease surrounding farm lands at considerable expense and continue to operate with a steam shovel or to install equipment for digging material from the wet pit.

Test holes showed that gravel extended to a depth of 30-ft. under water; in fact, approximately 25 per cent more material lay under water than had been above. It was found that a dragline cableway excavator could be installed to operate over a span of 700 ft. and would dig and convey material from any part of the pit, and this method was chosen.

Sand and Gravel Washery of Dayton Gravel & Sand Co.

The photograph shows the remodeled plant and also shows the car which was formerly hauled back and forth by a hoist carrying the material from the steam shovel to the bucket elevator which fed the washing screens. The dragline cableway excavator bucket which now does the work of the steam shovel and car in one operation, is shown in the view as it nears the hopper located on a tower erected at one side of the washery. The bucket, which holds 1½ yd. of material, dumps its load into the hopper where a "grizzly" rejects the large boulders and the remainder of the material is spouted to the screens. The bucket digs its load and makes the round trip in from one to two minutes.

The entire equipment of the old plant as far as screens, bins, etc., are concerned, remains unchanged in the new plant. The only new equipment is the Sauerman dragline cableway excavator, hopper tower, cableway mast, blocks, guy cables and a 90-hp. two-speed Thomas electric hoist to operate the excavator. The hoist is a special type built for dragline cableway work. It is equipped with band frictions. The two-speed feature gives a slow pull when digging and fast pull when the bucket is coming in on the cableway.

Surety Bonds Under Government Contracts

A review of the most important cases decided under the Federal statute (passed Aug. 13, 1894, and amended Feb. 24, 1905), for the protection of persons furnishing materials and labor for the construction of public works for the United States, was given by Mr. William B. King, of King & King, Attorneys, Washington, D. C., in a paper presented at the last annual meeting of the Association of Government Contractors. In his paper, an abstract of which is printed below, Mr. King cites some of the decisions rendered by the Federal courts, and shows what is now the settled construction of the act and what points yet remain undecided.

The language used in the act describing the contract under which the special bond must be given is that it must be "with the United States for the construction of any public building or the prosecution and completion of any public work or for repairs on any public building or public work." The same language was used in the original act of 1894.

The Attorney General was asked in 1900 whether the act related to contracts for the building of vessels and rendered an opinion that it did not, but 10 years later the Supreme Court of the United States declared this opinion erroneous and held that vessels were "public works." * *

The special obligation which the statute requires to be included in the bond is "that such contractor, or contractors, shall promptly make payments to all persons supplying him, or them, with labor or materials in the prosecution of the work provided for in such contract." A question very early arose under the act of 1894 whether this limited the bond to labor and materials furnished to the contractor directly, or whether it applied where these were furnished to subcontractors but entered into the finished work. The Supreme Court, when this question came before it, ruled that where the subcontractors employed certain men to do scraping and painting and left them unpaid to the extent of $141.80, these men could recover under the bond. The court admitted that, if literally construed, the obligation of the bond might be limited to secure only persons supplying labor or materials directly to the contractor, for which he would be personally liable, but they said that they must look at the manifest purpose of the statute to require that labor and material actually contributed to a public building should be paid for. On examination of the whole statute, they decided that the intention of Congress was "to protect those whose labor or material has contributed to the prosecution of the work" and that the "source of the labor or material is not indicated or circumscribed. It is only required to be 'supplied' to the contractor in the prosecution of the work provided for."

The following language of general interest was used by the Supreme Court in this case:

> The courts of this country have generally given to statutes intending to secure to those furnishing labor and supplies for the construction of buildings a liberal interpretation, with a view of effecting their purpose to require payment to those who have contributed by their labor or material to the erection of buildings to be owned and enjoyed by those who profit by the contribution of such labor or materials.

This is the principle which has governed the Supreme Court in all its decisions under this act.

As the language of the act of 1905 is the same in this respect as that of 1894, this decision was treated as binding when a like case arose under the latter act. The contractor employed a subcontractor to do the metal work, plumbing and roofing, who purchased materials from various manufacturers. The contractor paid the subcontractor in full, but he failed to pay the material men, who brought suit under the statute. The Supreme Court declared that their ruling in the preceding case held under the new statute and called attention to the fact that they had said in that case that the contractor could protect himself from liability by requiring a bond from his subcontractor and that the general contractor in this case reserved the right to require a release from material claims before paying the subcontractor. The purpose of the court was evidently to intimate that the contractor had neglected his proper protection in making payment to the subcontractor without showing that he had already paid the materialmen.

The Supreme Court has also declared that the statute is not limited to labor performed at the site of the work. In a later case a contract was for constructing a breakwater off Point Judith, Rhode Island. The stone for this purpose was furnished from a quarry about 50 miles distant. The workmen employed at the quarry brought an action upon the bond. The Supreme Court declared that this was a part of the work performed under the contract and came clearly within the class of labor accounts intended to be secured by the act of Congress.

This decision is of a very sweeping character and indicates very strongly, as do the other decisions cited, the purpose of the Supreme Court to give this act a very liberal interpretation to enforce its general purpose.

Many other decisions have been made showing exactly what kinds of work are and what are not included within the act.

It was held by a lower court, doubtless correctly, that a railroad company could not recover for freight earned in transporting materials, although it was held also in another case that a person furnishing materials and paying freight may add the cost of freight to the materials and recover therefor; and by the Supreme Court, that claims for cartage and towage were recoverable. It is not altogether easy to discriminate between the claim of a railroad for freight and that of a wagoner for cartage, but the Supreme Court justified its ruling in favor of the latter on the ground that it is not customary for a carter to enforce his lien for his charges before delivery and that the recognition of his rights under the bond is merely following the usual course of business in treating those charges as liabilities under the contract.

Where cars and equipment were rented for use on a contract, it was held that the rental and the return freight upon the cars could be recovered under the bond.

There has been much discussion over the question of machinery furnished for use on the work and repairs on such machinery. The Circuit Court of Appeals in Ohio drew a discrimination between machinery intended to be used and consumed on the work or intended to be used on the work and transferred to another job, if not used up. The court said the former was within the statute and the latter outside, but that the inclusion must be determined by the inherent character of the material and not by the fact of its being actually used up on unexpectedly extended work.

This is much the same distinction as was drawn in some earlier cases. It was held in one of these that minor repairs to machinery in use under the contract could be so allowed and in another that nails used both in the building and in the false work appertaining to it could be recovered as materials used in the work.

Somewhat akin to this is the question whether claims for furnishing coal used in making power in erecting the building are within the statute. This has been decided in both ways. The Circuit Court of Appeals in New York held that recovery could be had on such claims; but the Court of Appeals in the District of Columbia held that coal was not within the statute, following an earlier decision made by the same court that lubricating oil used in the operation of a dredge was not within the statute. In many states it has been held that powder consumed in blasting is the subject of mechanics' lien.

In view of the very liberal decisions of the Supreme Court under this statute, it would seem probable that coal and oil and powder would all equally be held to be proper subjects of suit on a bond under this law.

Another interesting question is whether payment can be enforced under the bond for board of workmen engaged on the work. This has been decided in the negative in two cases. The first of these was a claim of the keeper of a workingmen's boarding house for whose benefit deductions had been made of the pay of the workmen. The second was a case where groceries were furnished to the contractor's boarding house. It was held that this claim was not embraced within the statute, although it appeared that the conditions in the country where the work was proceeding made it necessary for the contractor to carry on such a boarding house.

A superintendent upon the work was allowed to recover under this statute, although it appeared that as a part of his pay he was to be given a share of the profits. In the same case, it was shown that the superintendent was allowed to check against his principal's funds and that he paid other creditors but did not pay his own salary, allowing that to accumulate. It was held that he did not lose his right against the surety by thus neglecting his own interests.

It has been held that bankers loaning money to pay laborers have no right to recover under this act. In a case before the Supreme Court certain persons took over a public contract under an agreement to do the work and receive the balance of pay from the government plus the retained percentage. It was held that they had no right to sue under this statute on the original contractor's bond to recover any balances expended to complete the contract in excess of the sum thus received.

Another case illustrates the converse of this. An indemnitor of the surety took up the contract after the original contractor found himself unable to complete the work and a subcontractor with the original contractor continued to furnish lumber to the indemnitor as successor. It was held that he was entitled to claim under the bond for the amounts furnished both to the original contractor and the indemnitor.

It was also held that assignments of claims under this statute will give a right to the assignee to file a suit.

This review of the judicial decisions affecting the scope of this statute leaves a very strong impression of the great liberality of the courts, and especially of the Supreme Court, in sustaining the rights of material-men and workmen. Questions of doubt seem to have been almost uniformly solved in their favor and against the contractor and surety, on the ground that the statute is remedial and that the remedy must be broadly construed.

The statute contains a number of provisions in regard to the time when the creditor may bring his action. If the United States sues, the creditor may intervene and be made a party to this action, but the act makes no provision fixing the time within which he must intervene. If the United States does not bring an action within six months "from the completion and final settlement of said contract," then the sub-contractor or other creditor may bring an action, but this action "shall be commenced within one year after the performance and final settlement of said contract." Where a suit is brought by a creditor, only one action shall be brought and any creditor may file his claim on such action and be made a party thereto "within one year from the completion of the work under said contract, and not later."

It will be seen that a number of interesting questions may arise. The first of these is whether the United States is limited to six months for suit and prohibited from suing later. That question has been answered in the negative and it is held that the United States can sue after this time has expired. It has not been settled how the United States is to proceed if a creditor's suit has been brought, whether by an independent suit or by intervention. If suit is first brought by the United States, there is no limit on the time of intervention by a creditor in that suit, but, in case where the suit of the United States had proceeded so far as to be submitted to the judge for decision, the application to intervene was thrown out on the ground that it came too late. Just where the line is to be drawn has not been decided.

If the United States brings no suit, what is the date from which the periods of six months and a year are to be computed? On this point, there have been many decisions. This date is described in one place by the words, "the completion and final settlement of said contract"; in another, "the complete performance of said contract and final settlement thereof"; and in a third, "after the performance and final settlement of said contract." Doubtless these three similar phrases should be construed to mean the same thing.

In a case before the Supreme Court, the action was brought by the creditors against the surety company in less than six months after the settlement, but after the United States had declared that it would not bring suit. After more than a year had elapsed from the settlement, an amended petition was filed in the cause. The Supreme Court declared that the right of the creditor was strictly limited by the terms of the statute; that he had no right to bring a suit earlier than six months after the settlement; and that the amendment could not be treated as an original action. Accordingly, the suit was dismissed.

In a later case before the Supreme Court the building was completed in July, 1912, and on Aug. 21, 1912, the Treasury Department made a statement of the account between the United States and the contractor fixing the balance due and this was paid on Sept. 11, 1912. The suit was brought on March 6, 1913, more than six months and less than a year after Aug. 21, 1912, but less than six months after payment, Sept. 11, 1912. It was contended that the suit was brought too soon. The Supreme Court decided that the word "settlement" referred to settlement of the account made in the Treasury Department and that suit was rightly brought.

It would seem that this might be a final disposition of all questions on this point, but numerous others have actually arisen. In June, 1916, only four months after this decision of the Supreme Court, the Circuit Court of Appeals in Philadelphia had to decide how to apply this decision. The Supervising Architect of the Treasury on Aug. 2, 1913, wrote a letter to the Secretary fixing the basis of settlement for the building at York, Pa. This was approved in an undated memorandum signed not earlier than Aug. 9. An action was brought by a creditor on the bond on Feb. 4, 1914, two days more than six months after the recommendation of the Supervising Architect, but less than six months after the action of the Secretary. The Treasury Department itself decided that the final settlement under the contract was Aug. 2 and not Aug. 9. The court said that it would follow this decision and declared the action properly brought. It seems very doubtful whether this is a correct construction of the rule laid down by the Supreme Court, for the action of the Supervising Architect was merely a recommendation and the final settlement was made by the Secretary. The decision of the Department, too, seems inconsistent with Department circular No. 45 saying that the date of final settlement is the "date on which the Department approves the basis of settlement under said contract recommended by the architect." Until the Supreme Court has passed on this question, it would not be safe to bring an action until six months after such date.

In contracts for public buildings, payments are made, as has been seen, upon settlement by the Secretary of the Treasury, by disbursing officers' checks. In other branches of the government, settlements are otherwise made and the rule of the statute must be differently construed. Thus in the Reclamation Service, all payments under contracts are made upon settlements by the Auditor of the Treasury for the Interior Department. In a case of this kind, it was held that the Auditor's settlement determined the date from which the six months should be counted. In a case arising in the War Department, the Quartermaster General stated the account and allowed a fixed sum to the contractor. Slightly more than six months after this a suit was filed upon the bond. Still later the Comptroller of the Treasury revised the settlement as made by the War Department and allowed a slightly different sum. The court held that the action was prematurely brought and that the six months dated from the settlement by the Comptroller of the Treasury.

In a case arising in the Navy Department, a statement of account was made. The voucher issued thereon was returned to the Department by the contractor in the expectation of payment, but correspondence in the Department ensued resulting in a restatement of the case at a considerably later date and the allowance of a slightly smaller sum, which was subsequently paid. An action brought more than six months after the first settlement of the account, but less than six months after the final statement was held to have been prematurely brought and was dismissed.

The rule of law governing this subject is very finely stated in a recent case by the United States Circuit Judge Lacombe in the following words:

> The date was, therefore, fixed relatively to "complete performance of the contract and final settlement thereof." We take it that these words refer to the time when the proper government officer, who has the final discretion in such matters, after examination of the facts, satisfies himself that the government will accept the work, as it is, without making any claim against the contractor for unfinished or imperfect work, damages for delay or what not, and records that decision in some orderly way. Six months after that date, material men may begin suit.

This is the principle recently approved by the Supreme Court, but we have seen that the real difficulty is not in the statement of the principle, but in its application to the different conditions which arise in different branches of the United States Government.

A very difficult clause is the last proviso requiring personal notice to creditors of the pendency of the suit and notice of publication "for at least three consecutive weeks, the last publication to be at least three months before the time limited therefor." There is nothing to which the word "therefor" clearly relates. Does it mean before the time limited for a creditor to appear by intervention, In that event, the time within which the original creditor can file his suit would be reduced by the term of three months and three weeks. He could only bring his suit after six months, but it must be brought then within a period of three months, less three weeks, so that the advertising can all be completed within one year. This would leave only two months and one week for bringing suit. Although it seems absurd to think that Congress meant any such limitation as this, one of the United States Circuit Courts of Appeals so held, although another such court had held to the contrary. This decision was promptly corrected by the Supreme Court when the question came before it. The plaintiff there both gave personal notice and advertised for creditors, but the last publication of the advertisement (Nov. 25, 1908), was seven days less than three months before the end of the year (Feb. 19, 1909), after the final completion of the contract. The Supreme Court treated the question as one of very serious difficulty and concluded that the language of the proviso was irreconcilable with the language of the rest of the act. The court said that, where irreconcilable provisions occur, "we can only select those which we consider the fittest to prevail to accomplish the purposes of the statute." The court held that a failure to observe the provisions in regard to advertising was not fatal to the right to bring suit.

Where the action was brought by the United States, it was twice held that advertising is not required.

It is a settled rule of law that alterations in the contract with the principal, even where they are to his benefit, releases the surety. The ground of this is that the surety has undertaken to become responsible for the execution of a certain contract and no other. If the principal and the person guaranteed change the contract, the surety has a right to say that he never guaranteed the performance of the new contract.

A case arose in Washington under the District of Columbia surety bond law, which is substantially the same in this respect as the statute governing United States contracts (Act. of Feb. 28, 1899, 30 Stat. 906), whether the responsibility of the surety company under the provisions of the bond protecting sub-contractors was abrogated by a change in the principal contract. A contract had been made for building a school house and, without the knowledge of the surety company, the plans of the school house were changed so as to face it on a different street, considerably altering the amount of grading to be done.

The contractor failed to pay his sub-contractors and suit was brought by them on the bond. The Supreme Court said that the general principle above stated did not apply under this bond; that the sub-contractor or material man is the person protected and that, as he was not consulted in regard to the change, his rights can not be forfeited through the action of the other parties to the bond. It was held that the sub-contractors had a right to sue on the bond, notwithstanding the change, saying:

> * * The surety is charged with notice that he is entering into what is in a very proper sense a public obligation, and one that will be relied upon by persons who can in no manner control the conduct of the nominal obligee, and with respect to whom the latter is a mere trustee, and therefore incapable, upon general principles of equity, of bartering away, for its own benefit or convenience, the rights of the beneficiaries.
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> * * * * * *
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> * * If the change were so great as to amount to an abandonment of the contract and the substitution of a substantially different one, so that persons supplying labor and materials would necessarily be charged with notice of such abandonment, a different question would be presented.

This is a caution which may become important in the future.

It is an ordinary rule of the law of suretyship that a surety is released from obligation in case the time fixed for performance of the contract by the principal is extended without the surety's consent, for the same reason as above stated—that the surety has agreed to guarantee one contract and can not be called upon to guarantee another.

The Supreme Court, in considering the rights of creditors under the act of 1894, ruled with great liberality on another point relating to this principle. The materialman here granted an extension to the contractor and took notes for 30 to 60 days in payment for brick furnished. The court held that the above rule did not apply, but that, in the absence of any prejudice shown to the surety by the extension of the time, he was still bound to the payment of the debt to the materialman. The decision was put upon the following ground:

> * * The guarantor is ignorant of the parties with whom his principal may contract, the amount, the nature, and the value of the materials required, as well as the time when payment for them will become due. These particulars it would probably be impossible even for the principal to furnish, and it is to be assumed that the surety contracts with knowledge of this fact. Not knowing when or by whom these materials will be supplied, or when the bills for them will mature, it can make no difference to him whether they were originally purchased on a credit of sixty days, or whether, after the materials are furnished, the time for payment is extended sixty days, and a note given for the amount maturing at that time. If a person deliberately contracts for an uncertain liability he ought not to complain when that uncertainty becomes certain.

Although the decision of the Supreme Court above cited holds that a reasonable extension of the time of payment given by a sub-contractor to a contractor did not deprive the sub-contractor of the right to recover on the bond, yet the need of a limitation on that doctrine is shown in a case decided as late as June, 1916, by the Circuit Court of Appeals in Philadelphia. The contract with the United States provided for monthly estimates in proportion to the work done and the sub-contract with a marble company provided for payments from the contractor in proportion to the money received from the United States. Instead of that, the marble company took a small amount in cash and the contractor's notes for larger sums than the amounts agreed upon. These notes were discounted. A year before the final payment the marble company had received almost its entire due in cash and notes, but very much less than the amount due up to date in cash. It was held that the surety company was released by any such change of contract between the contractor and the sub-contractor. The court summarized its position in the following statement:

> * * In brief, a corporate surety under the act of 1905 is much like the signer of a blank check. Undoubtedly such a man takes a risk; if a larger sum should be inserted than he intended, he must usually accept the situation; but, after the blank has been filled, his liability is fixed, and is not subject to injurious change thereafter

This decision gives notice to sub-contractors and material men that they must be extremely careful in changing the terms of contracts once made with the general contractor.

It was held by the Circuit Court of Appeals in Chicago that the surety was not released by the creditor consenting to an assignment of the contract or by his accepting payment on account from the assignee or by filing his claim against the assignee's estate in bankruptcy, or even by aiding in the assignment by the original contractor to a corporation and taking part as a director in the corporations.

This completes the review of the most important cases by the courts under this statute. It shows that the Supreme Court has recognized it as a substitute for lien laws, as designed to secure payment for work done and material furnished and as of a highly meritorious character. General contractors assert that the courts have gone so far in protecting such claims that they have been involved in liabilities against which they can not possibly guard. Two things may now be added by way of suggestion to the contractors:

1. That, while the present law stands, they must use every possible care in protecting themselves either by dealing only with thoroughly responsible sub-contractors or by requiring bonds from sub-contractors as a protection against claims for material furnished to the sub-contractors or to the sub-contractor's sub-contractor. Even with the utmost care in this respect, it is very questionable whether the contractor can always feel that he is safe in making his settlements and payments.

2. That an effort should be made to secure an amendment to the law. It would certainly seem fair to change the law so as to require a material man to give notice to the general contractor at the time of furnishing the material that he proposes to hold the contractor responsible for it. This would be no hardship to the material man. The notice would be given in cases where the material man had any doubt about his being paid by the sub-contractor. A rule of practice might, indeed, be adopted by material men to send such notice to the general contractor in every instance. The general contractor could have no objection to this for, being forewarned, he could protect himself. It is the unsuspected claims that give him ground for complaint.

The Interstate Commerce Commission has compiled the following advance figures from the reports of operating revenues and expenses of 178 railroads for the month of May:

Item.	May, 1917.	May, 1916.
Average number of miles operated	227,514.05	227,109.97
Railway operating revenues	$337,869,250	$294,517,994
Railway operating expenses..............	233,147,873	193,348,746
Net revenues from railway operations.	$104,721,377	$101,169,248
Revenues per mile	1,485	1,297
Expenses per mile	1,025	851
Net revenue per mile	460	446

During the past year New York City added 2½ miles of new wharfage to the city's docks.

Sewer Construction by Open Cut and Tunnel Methods in Sanitary District of Chicago

An interesting comparison of sewer construction by open cut and tunnel methods was given by Mr. H. R. Abbott, Assistant Engineer, Sanitary District of Chicago, in a paper presented June 4 before the Western Society of Engineers. In his paper Mr. Abbott describes the method of work, construction problems, and their solutions, on some 18 miles of intercepting sewer construction in the northern end of the Sanitary District of Chicago. The paper is divided into two sections, one dealing with the North Shore intercepting sewer which was completed on Jan. 1, 1916, and the other with the Evanston intercepting sewer which is now under custodian. An abstract of that portion of the paper relating to the North Shore sewer follows:

The North Shore intercepting sewer is about 9 miles long, and serves the villages of Wilmette, Kenilworth, Winnetka and Glencoe. It intercepts five sewer outlets from Lake Michigan and four from the Skokie. The project is divided into three contracts: Contract No. 1, 2.7 miles in length, beginning at the North Shore Channel and terminating at Cherry St., Winnetka; Contract No. 2, 1.3 miles in length, branching from Contract No. 1 at Winnetka Ave., Winnetka, and extending west largely in tunnel to a junction with Contract No. 3; Contract No. 3, 4.7 miles in length, extending along western limits of Winnetka and Glencoe and terminating at Longwood and Hazel Aves., Glencoe. Actual construction on Contract No. 1 was started at the North Shore Channel on May 5, 1914. This contract was built entirely in open cut, the average cut being 21½ ft. The excavation was made by a Bucyrus 70-ton steam shovel, mounted on timbers to span the trench, and fitted with a 54-ft. dipper handle. In the maximum cut of 26 ft. some hard work was required on account of the excessive depth. The average daily progress for an entire working season was 70 ft. or 480 cu. yd. of excavation. The maximum daily run was 125 ft. or 850 cu. yd. of excavation. All sheeting was left in place to prevent any sloughing of the banks, but largely, however, to protect the adjacent local sewer and water pipes, although the entire section was in good stiff blue clay.

The sewer section of this contract is egg-shaped, built of monolithic concrete of 1:2½:5 mix, and is 6x9 ft. in size merging into a 6x8 ft. The slopes are 1 in 2,000 and 1 in 2,500. Blaw steel forms of a collapsible type were used, the sections being 5 ft. in length. Both invert and arch forms were carried ahead by travelers. The arch traveler was 12 ft. long and carried 15 ft. of form per trip. This traveler was carried on 9-in. flanged wheels, running on a small T-rail, supported on cross timbers placed about 3 ft. above the invert. The invert traveler carried one 5-ft. length of form ahead each trip, suspended from a small boom equipped with wire rope, cleaves and winch. The rear end of this traveler was counterweighted to maintain stability. For the job 130 ft. of invert and 200 ft. of arch forms were employed. The invert form was supported on concrete blocks 9x10x14 in. spaced 5 ft. centers. These blocks were cast outside the trench and cured, being placed to line and grade as soon as the bottom was shaped up, after which the space between the blocks was filled with concrete from the mixer. The concrete mixer was mounted to span the trench and deposited the concrete through a flexible jointed chute.

All material was teamed to the work, the average haul being 1¼ miles. Spoil was loaded direct from the shovel into 2½-yd. dump cars and hauled to the dump or back fills. Seven cars formed an average train. The dump was situated in a ravine and along the shore of Lake Michigan, near the middle of the contract. Dumping was carried out parallel with the bluff, making 30 to 40 ft. of additional land, some 1,500 ft. in length.

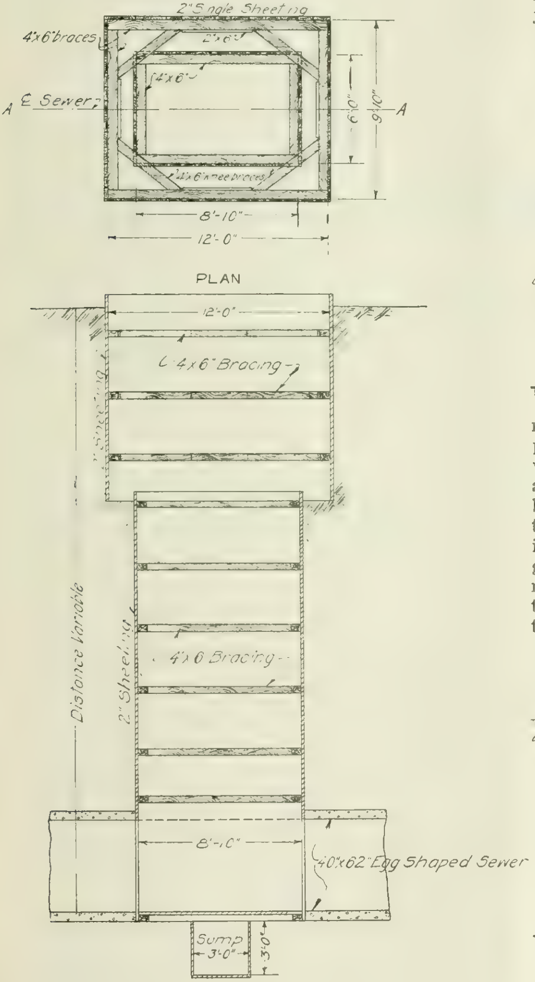
Four sewer outfalls discharging into Lake Michigan were intercepted on this contract. These were provided with spillways utilizing the old sewers between the interceptor and the lakes as overflows for excessive storm floor. An output of 0.8 ft. of completed sewer per day per man was obtained.

Contract No. 2 comprises a modified ellipse shaped sewer 62 in. in size built partly in open cut and partly in tunnel with a slope of 1 in 1,250. On the open cut section a Parsons excavating machine was used, spoiling alongside the trench. As the work was in an unpaved street, continuous sheeting was not used. Several cave-ins occurred due to leakage from an existing tile sewer, which in places was exposed in the side of the trench. The Blaw forms used on this section were in 5-ft. lengths, five lengths being bolted together as one unit when moving ahead. The concrete invert was laid ahead, the invert forms then being dragged ahead by block and tackle. The arch forms were equipped with 5-in. castor wheels bolted to the forms and were carried on wooden stringers supported on cross timbers. The collapsing of the forms was done with a turnbuckle attached to the forms and also serving as a cross brace. Fifty feet of invert and the same amount of arch forms were used on this section.

Concrete was mixed in a 10-ft. capacity Whirlpool gas engine mixer and chuted into the work. Very little excavated material was hauled away and backfilling was done by teams. The output was 0.66 ft. per man per day, or a daily average progress of 25 ft.

From the east right of way line of the C. & N. W. Ry. to the west end of this contract, the sewer was built in tunnel passing under the Indian Hill Golf Club. Three shafts were sunk at an average distance apart of 1,400 ft. The shafts were rectangular and 6 by 8 ft. inside of timbering. In sinking the shafts the excavated material was scaffolded up. The work in the tunnel was carried on 24 hours a day in three shifts, two mining and one concreting. Owing to the nature of the ground very little timbering was necessary, occasional crutches and light poling boards being used where the roof showed a tendency to slough off. In all such cases the poling boards were concreted in but the crutches were removed. A regular mining program of 10 ft. for each 8-hour shift in each heading was followed. This 20 ft. mined each day was lined in the 8-hour concrete shift, making a total progress of 40 ft. in the two headings every 24 hours. This is equivalent to 0.85 ft. per man per day. Concrete for lining the tunnel was mixed at the top of the shaft by hand, loaded into muck cars and pushed by hand to the headings. A strongly timbered 2-story headhouse carried the elevator which was operated by a steam hoist. The muck was raised to the second landing and run out onto a dump track to be dumped onto the muck pile or into wagons. At the completion of the tunnel-work driven from any one shaft, the headhouse, hoist and boiler were moved on to the next shaft. Ventilation for the tunnel was furnished by blowers operated by a belt from a special engine. The Blaw forms for this tunnel section were the ordinary knock-down forms consisting of ribs and lagging plates, the plates being 5 ft. long and 18 to 21 in. in width; 80 lin. ft. were used on this section.

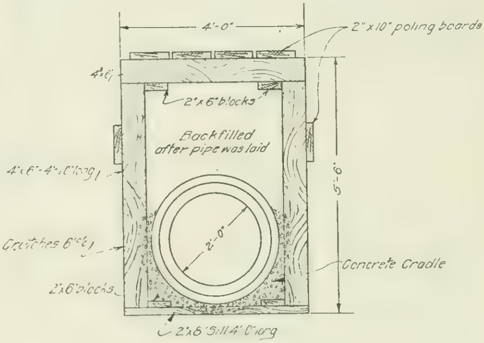
Contract No. 3 extended along the eastern edge of the Skokie Marsh, on a diagonal line, cutting through the private property, including subdivisions, farm land, private estates and the Skokie Golf Club grounds. The contract included 36, 33, 30-in. ovoid-shape concrete and 24, 18, 12 and 9-in. tile sewers beginning with a slope of 1 in 1,500 and gradually increasing to 1 in 540 upper end. This contract section was specified to be built in open cut, except the 2,400-ft. of 24-in. tile on Milton Ave., Glencoe. The contractor, however, after building the first 1,100 ft. north of the junction with Contract No. 2, and making very unsatisfactory progress, decided to build all of the balance in tunnel. The open-cut work showed that the tunnel would be in fairly good clay, although the first 6 ft. below the ground level was a very sandy loam, and would give trouble in an open cut unless Wakefield sheeting was used. Shafts were sunk at short intervals for the entire balance of the work or 3¾ miles, this stretch having 92 shafts with 184 headings. The headings averaged 207 ft. in length on the 36, 33, 30, 18 and 12-in. sections. The total length of shafts of this character was 1,943 lin. ft. or just about 10 per cent of the entire length of the tunnel as built from these shafts. An average day's progress on this work was 57 ft., including the shaft work, or very nearly 1 ft. per man per day, as against a progress of but 25 ft. per day on the 1,100 ft. done by open cut on the same sewer. Owing to the extremely small working space in these sections, it was impossible to concrete the sewer as the work progressed. The expedient was therefore adopted of mining continuously between shafts and concreting the whole length of the heading from the face back to the shaft after the mining had been completed.



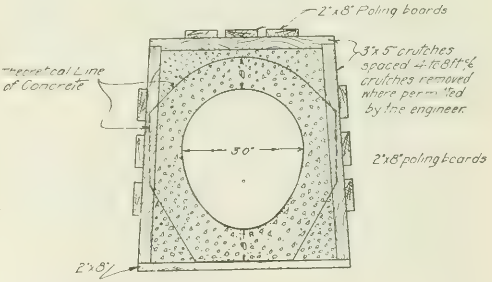
PLAN

SECTION AA

Timbering Plan for Shafts on 40 in. by 62 in. Concrete and 24-in. Tile Sections.



Timbering Method on 24-in. Tile Sewer, Milton Avenue, Glencoe.


2"x8" Poling boards
3"x5" crutches spaced 4 to 8 ft. & crutches removed where permitted by the engineer
Theoretical Line of Concrete
30"
2"x8" poling boards
2"x8"

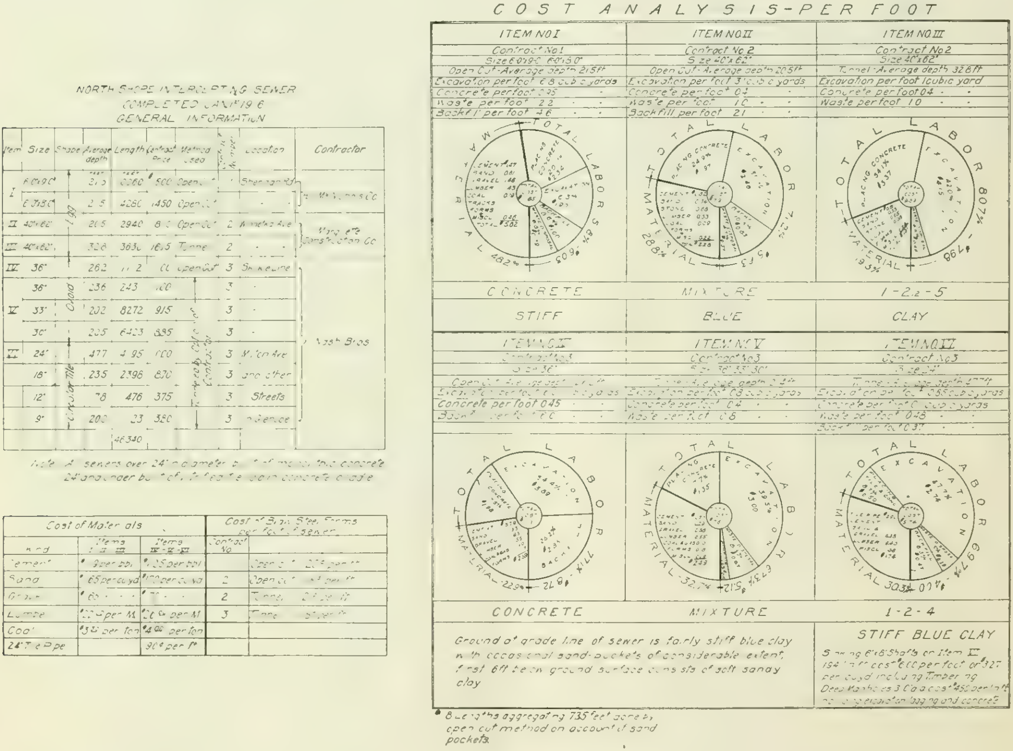
Timbering Method on 30-in., 33-in. and 36-in. Sewers on Skokie Line.

These shafts, averaging only 21 ft. in depth, were circular and 6 ft. in diameter, using the ordinary sewer iron rings and 2-in. wood lagging. They were sunk by two special crews, the first excavating and sheeting the shaft to a depth of 10 ft. and scaffolding out the material. The second gang completed the shaft and usually cut and timbered the eyes, hoisting the material out with a carriage wheel winch, such as is used for lowering pipe into a trench, but geared up to give more speed.

Because of the frequent shifting required, very little plant was used. Two light 2-story timbered head-houses, built on skids, were used, one being in operation at the shaft where mining was under way, while the other was set up at the shaft ahead. The power plant was a single drum hoist and a portable 30-hp. boiler. The whole outfit was moved ahead, set up and put in operation in less than 2 hours. Muck was brought from the face to the shaft in tubs carried on small flat cars. No elevator was used, the tubs being hooked directly onto the hoisting table, raised to the second landing of the headhouse and dumped into the spoil wagons. Concrete was mixed in a Whirlpool gas engine mixer of 10-cu. ft. capacity, and chuted down the shaft into dump cars which were pushed to the headings. Forms were removed by a special gang after the concrete and mining gangs had gone on to the next shaft. This gang also pointed up, plastered the invert and concreted up the opening at the shafts. The forms used in concreting the shaft opening had to be removed through the next shaft. Sand pockets of considerable extent encountered along a stretch of ¾ mile prevented the work being done in tunnel at these points with the means at hand. The work at these places was then carried on by the open-cut method, making the excavation by hand, the open cutting in eight separate pieces totalling 723 ft. in the 3¾ miles of work. These open-cut sections proved very expensive to the contractor. Built-up wooden forms were used on the 33 and 30-in. sections and the Blaw steel forms on the 36-in. section, using 128 ft. of the steel forms and a similar length of wood form on the other two sections. All material was delivered by teams and for about one-half of the contract section it was necessary to lay plank roadways extending from the end of the nearest paved street to the site of the work. The planking in these roadways, however, was taken up and used again and again. The average haul for material was 1½ miles. Four outfall sewers were picked up on this contract, intercepting the sewage which fomerly flowed away in open ditches.

The 24-in. tile section was specified as tunnel in the contract; it was driven from four shafts averaging 49 ft. in depth, spaced approximately 1,000 ft. apart, making the headings 500 ft. long. All shafts were sunk at the site of manholes and other manholes were built in specially excavated wells between the shafts. The shafts were similar to shafts described on Contract No. 2. Excavated material was scaffolded out to a depth of 12 ft., after which a windlass mounted on a tripod hoisted out material in buckets. Excavation for the intermediate manholes was made in circular wells 4 ft. 8 in. in diameter, sheeted with 2-in. lumber secured in place by steel rings and material hoisted out by a windlass. No trouble was encountered in sinking these wells to a maximum depth of 60 ft.

From these shafts, the mining was carried on continuously for the full length of the heading, the tunnel being timbered as the work advanced and track laid. Muck cars ½-cu. yd. capacity were used and hoisted to the second landing of the headhouse and muck dumped into wagons. As soon as the headings were completed, the tile was laid in a concrete cradle beginning at the far end of the heading and working


NORTH SHORE INTERCEPTING SEWER
COMPLETED JAN. 19[illegible]6
GENERAL INFORMATION

Item	Size	Shape	Average depth	Length	Contract Price	Method used	Contract Number	Location	Contractor
I	6'0"x9'0"	Egg	21.5	[illegible]060	$500	Open cut	1	Sheridan Rd	[illegible] Co
	6'0"x8'0"		2[illegible].5	4260	1450	Open cut		"	
II	40"x62"		20.5	2940	8[illegible]	Open cut	2	Winnetka Ave	[illegible] Construction Co
III	40"x62"		32.8	363[illegible]	16.5	Tunnel	2	"	
IV	36"		26.2	[illegible]2	[illegible]00	Open cut	3	Sh[illegible]	Nash Bros
V	36"	Ovoid	23.6	243	[illegible]00	[illegible]	3	"	
	33"		20.2	8272	915		3	"	
	30"		20.5	6423	885		3	"	
VI	24"	Circular Tile	47.7	4[illegible]95	[illegible]00		3	Milton Ave	
	18"		23.5	2396	8[illegible]0		3	and other	
	12"		[illegible]8	476	375		3	Streets	
	9"		20[illegible]	[illegible]23	380		3	[illegible]	
				46340					

Note: All sewers over 24" in diameter built of [illegible] concrete. 24" and under built of [illegible] tile [illegible] concrete cradle.

Cost of Materials			Cost of Blaw Steel Forms per foot of sewer	
Kind	Items I-II-III	Items IV-V-VI	Contract No.	
Cement	$[illegible] per bbl	$1.25 per bbl		Open cut [illegible] per ft
Sand	$.65 per cu yd	$[illegible] per cu yd	2	Open cut [illegible] per ft
Gravel	$.65 [illegible]	$.7[illegible]	2	Tunnel [illegible] per ft
Lumber	$[illegible] per M	$[illegible] per M	3	Tunnel [illegible] per ft
Coal	$3[illegible] per ton	$4.00 per ton		
24" Tile Pipe		90¢ per ft		

COST ANALYSIS—PER FOOT

ITEM NO I	ITEM NO II	ITEM NO III
Contract No 1	Contract No 2	Contract No 2
Size 6'0"x9'0" 6'0"x8'0"	Size 40"x62"	Size 40"x62"
Open Cut-Average depth 21.5 ft	Open Cut-Average depth 20.5 ft	Tunnel-Average depth 32.8 ft
Excavation per foot 6.8 cubic yards	Excavation per foot 3.[illegible] cubic yards	Excavation per foot 1 cubic yard
Concrete per foot .35 " "	Concrete per foot .4 " "	Concrete per foot .4 " "
Waste per foot 2.2 " "	Waste per foot 1.0 " "	Waste per foot 1.0 " "
Backfill per foot 4.6 " "	Backfill per foot 2.1 " "	
CONCRETE	MIXTURE	1-2.2-5
STIFF	BLUE	CLAY
ITEM NO IV	ITEM NO V	ITEM NO VI
Contract No 3	Contract No 3	Contract No 3
Size 36"	Size 36" 33" 30"	Size 24"
Open cut-Average depth [illegible]	Tunnel-Average depth 2[illegible]	Tunnel-Average depth [illegible]
Excavation per foot [illegible] cubic yards	Excavation per foot .08 cubic yards	Excavation per foot .055 cubic yards
Concrete per foot .045 " "	Concrete per foot .04 " "	Concrete per foot [illegible] cubic yards
Backfill per foot [illegible] " "	Waste per foot .08 " "	Waste per foot .048 " "
		Backfill per foot .03[illegible] " "
CONCRETE	MIXTURE	1-2-4

Ground at grade line of sewer is fairly stiff blue clay with occasional sand-pockets of considerable extent; first 6 ft. below ground surface consists of soft sandy clay

STIFF BLUE CLAY

Sinking 6'x8' Shafts on Item [illegible] 194 [illegible] cost $6.00 per foot or $3.27 per cu yd including Timbering. Deep Manholes 3 [illegible] cost $450 per [illegible] [illegible] excavation, [illegible] and concrete

* 8 Lengths aggregating 735 feet done by open cut method on account of sand pockets.

General Information and Cost Analysis for North Shore Intercepting Sewer of Sanitary District of Chicago.

back to the shaft. Tile was brought in one at a time on the dump cars, the sides of the car being removed. All joints were calked with jute soaked in cement grout and plastered. The backfill was brought down the shaft in the muck cars and packed over the pipes as laid, the usual procedure being to lay about four lengths of pipe and then backfill. This section was in uniformly good stiff blue clay and work was performed under a sub-contract.

A more permanent plant was used on this job than on the 36, 33 and 30-in. concrete sections. The headhouse was a heavily timbered 2-story affair, equipped with a 6-ft. cage elevator. A dump track was laid from the second story out over a dumping trestle, under which the wagons could drive. Hoisting plant consisted of a double-drum hoist operated by a 40-hp. vertical boiler. A small blower was geared to the shaft of the idle drum to furnish air for ventilation and operated as needed. No compressed air was used. At the completion of the work from one shaft, the boiler, hoist and headhouse, all mounted on skids, were moved ahead to the next shaft by teams pulling with block and tackle from deadmen. Two days were required to move and re-assemble the plant.

For connecting local sewers, a cast-iron drop pipe was built, extending from the connecting sewer down to the 24-in. sewer and carried outside of the manhole. The drop pipes were encased in concrete. The work on the 18 and 12-in. tile sewers on the extreme end of the contract was carried on in a similar manner to that employed on the 36, 33 and 30-in. sections except that the shafts were closer together. An average daily progress on the 24-in. tile in tunnel was 41 ft. or 1 ft. per man per day.

From the data collected diagrams have been made showing the proportional costs for the different parts of the entire work. For the purpose of cost analysis the entire 9 miles of sewer is divided into six items, each item shown being divided proportionately for its different parts. Comparison of the wheel diagram and the general information table shows that Item 1 afforded a good margin of profit. This item was a well-balanced job; that is, the labor and material about divide the circle in half. This proportion will generally show a good margin of profit on an open-cut job.

Taking Item 2, also an open-cut job, it will be seen that there is practically no profit and the proportion of labor to material is 71 per cent to 29 per cent, respectively, or entirely out of proportion.

Item 3 is in tunnel and shows a good margin of profit, with the labor 81 per cent against material 19 per cent. This can also be called a well-balanced job, as on tunnel work the labor should run considerably higher than on open cut, with a corresponding decrease for material on the proportional cost, or about 75 per cent for labor and 25 per cent for material.

Item 4 is the 1,100 ft. of open cut referred to above, and where this method was abandoned and tunnel substituted. It shows no profit, with the labor item at 77 per cent and material at 23 per cent, and in contrast with this a reference to Item 5 gives the cost of the same sewer after the contractor changed his method of work from open cut to tunnel. The item shows the labor as 67 per cent and the material at 33 per cent. Comparison will show a profit. The 36, 33 and 30-in. sizes are grouped together under this item, as the work is all of the same character and very little difference was found in the actual amount of material used.

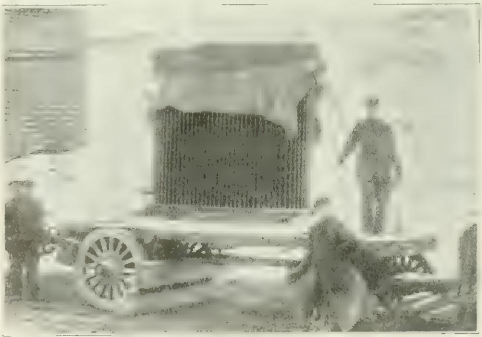
Item 6 completes the cost data for the North Shore sewer and is the 24-in. tile in tunnel. This is a well-balanced diagram, with a corresponding margin of profit, with labor at 70 per cent and material at 30 per cent. Should the cost per cubic yard be desired on any of these items shown in the diagrams, it is only necessary to divide the cost of that item by the number of yards shown above the circle.

The cost diagrams do not include overhead charges, first cost of plant, depreciation, interest or bonding. They do, however, include all field expenses, including the liability insurance on contractor's employes and superintendence.

The construction work was carried out under the supervision of Mr. Abbott as Assistant Engineer for the Sanitary District of Chicago, under the direction of Mr. Langdon Pearse, Division Engineer, and Mr. George M. Wisner, Chief Engineer. The contractors for the three sections of the South Shore intercepting sewer were as follows: Contract No. 1, H. J. McNichols Co.; Contract No. 2, Marquette Construction Co.; Contract No. 3, Nash Brothers.

Wheel Brake for Heavy Loads

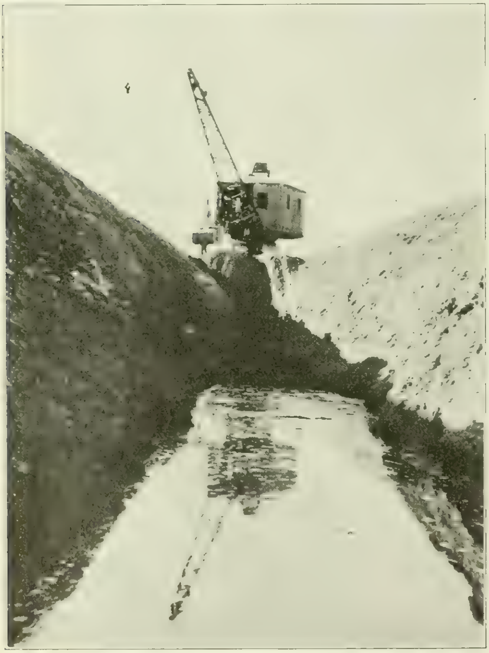
An effective brake for use on trucks in transporting heavy loads down steep roadways has been developed by the Construction Department of the Rochester Railway & Light Co., Rochester, N. Y. The device consists of two heavy blocks attached to the truck and hanging about the center of the back wheels, both in front of the wheel and in back. The blocks are controlled by means of two rods which run from the hand wheel at the rear block to a nut on the front block. It is stated that this brake alone will safely conduct a load of 10 tons down a steep incline, but for heavier loads and as a safeguard, a third block shaped to coincide with the rim of the wheel is used. As this block drags on the ground there is a tendency for the rear wheels to ride over it. In cases where a load heavier than 10 tons is being hauled it is necessary to put a team of horses in back of the wagon and hitch it to the block which drags on the ground, thus making a secure hold-back. In transporting a load from 20 to 25 tons it is necessary to attach two teams, but if loads ranging from 25 to 50 tons are hauled a hoisting engine is attached. The pull on the rope attached to the block has the same effect as if the horses, or hoisting engine were holding back a heavy load. The illustration, reproduced from the Gas and Electric News from which this note is taken, shows an 11-ton transformer being taken down a hill.



Wheel Brake Developed by Rochester Ry. & Light Co.

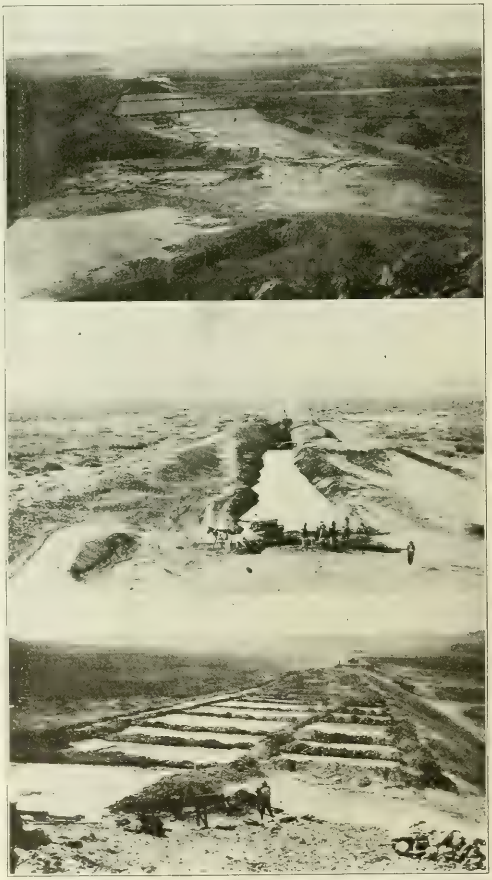
Earth Dam Compacted by Flooding

Construction is now nearing completion on a $250,000 project for securing an additional water supply for Reeves County Irrigation District No. 1 of Texas. The work is located near Balmorhea, Tex. It involves the construction of diversion works with earth wing walls and reinforced concrete spillway 500 ft. long, by which the flood waters are taken from Madero Creek and carried through an intake canal 4½ mile in length into a creek which empties into a storage reservoir. This reservoir is formed by an earth dam containing about 180,000 cu. yd. of material, which was excavated from the bottom of the reservoir by Western elevating graders and hauled to place in Western dump wagons. The canal excavation has been handled by Monigan draglines.


Excavating Cutoff Trench With Dragline.

In the construction of the dam the somewhat unusual method of compacting the earthwork by irrigating was employed. The distance of the work from the nearest source of water supply made it impracticable to follow the common method of sprinkling by wagons, and large quantities of water being necessary in the work of puddling, as well as for stock and other purposes, it was thought best to provide a constant supply. This was provided by means of a small ditch nearly 3 miles long, diverted high enough to carry the water over the top of the completed dam.

In order to cut off a gravel stratum at the dam site a trench averaging 40 ft. wide at the top and from 5 ft. to 15 ft. wide at the bottom, and 10 to 20 ft. deep was excavated to rock or clay foundation. This was filled with water and good earth material "bulldozed" in from the end. Over this puddled trench the dam, which is 47 ft. high and 2,500 ft. long was built in 3-ft. lifts. Each lift or layer as completed was bordered and cross-bordered where necessary, and flooded with water as shown in the illustration. This water was allowed to stand for several days, the intention being to permit the moisture to connect with that of the lift next below. On testing out these lifts with a post hole digger after irrigation, it was found that the earth was well compacted, and a very complete impervious settlement obtained quickly. This process of settling and compacting the material was continued to the very top of the dam.


Top View, Dam With First Lift in Place. Middle View, Puddling Cutoff Trench. Bottom, Method of Retaining Water in Puddling.

The inner slope of the dam will be protected from wave action by a specially laid reinforced concrete paving. This paving is made in slabs 6 ft. wide running up the slope from a concrete toe wall at the bottom to the top of the dam, the slabs being 7 in. thick at the bottom end and gradually diminishing to 4 in. thickness at the top. The joints between the slabs were formed in a step or off-set manner with felt between. The reinforcements of continuous heavy netting passed through this joint diagonally at the step or off-set point and just below the felt. The reinforcing going through the joint at the step diagonally, was for the purpose of allowing for expansion and contraction without undue tension on the reinforcing material. The step joint also provided for expansion without leaving an opening for leakage of water, as the step part of the joint will always be tight. The inner slope of the dam was thoroughly wetted and tamped to a firm foundation before laying the concrete.

The outlet from the reservoir is through a saddle where a cut of 21 ft. was made and a reinforced concrete conduit was put in and a refill of puddle clay made for the foundation of a small dam above.

Vernon L. Sullivan is Chief Engineer of the Reeves County Irrigation District No. 1 and R. S. Watrous is Resident Engineer. Jamieson & Co., are the contractors for the main dam.

Drag Line Skip and Stiff-Leg Derrick Facilitate Foundation Excavation

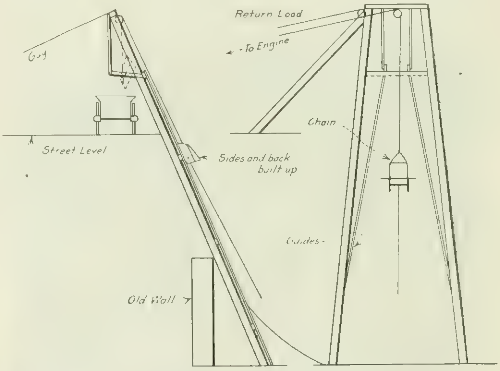
In excavating for the foundation for the new plant of the French Bros.-Bauer Co. now being erected at Canal and Plum Sts., Cincinnati, O., rather unusual conditions had to be met. The foundations of an old brewery with heavy stone walls and arched ceilings of old wine cellars, some covered with 6 to 10 ft. of earth, were to be partly removed and partly reused as foundations of the new building. Some groined arches and brick arches supported on steel beams and cast iron columns were removed. As the elevation of the sub-basement floor varied, the excavation had to be finished in one section before proceeding with another of different elevation.

Stiff-Leg Derrick Used in Excavating Building Foundations.

Work began at the east end to get sufficient earth moved to allow underpinning an existing brick building. On this and the center portion of the site, a stiff-leg derrick with a 60-ft. boom, 40-ft. mast and a ¾-yd. Owens bucket operated by a Dake swinging engine, was used. This derrick was supported on the old cross walls and arches on the center line of the building. The bucket discharged either into wagons direct or into an elevated bin, so that when the teams were not there the derrick could work continuously. An average of 28 yd. per hour was maintained at a labor cost of 48 ct. per yard. To haul this about 1¼ miles required 16 teams, the round trip time being about 1 hour 15 minutes. This cost includes tearing out the stone arches and walls.

Owing to the underpinning, the east end was not completed until after the remainder of the work was practically finished. The depth here was 30 ft. below the street. As room for a derrick was not available, the drag line skip as shown in sketch was erected on the street side, arranged to operate from the concrete hoisting engine. The scraper used was of ½-yd. capacity with the sides and back built up and a chain bail substituted for the iron one. Dirt was taken out at a unit labor cost of 32 ct. per yard. This excavation was in sand and loam and involved no tearing out of walls. This drag line skip, while it took out dirt cheaper than with the derrick, could not have been used throughout the job on account of the cost of moving and erecting, and the interference from cross walls in other parts of the building.

The old stone walls had been laid up in cement mortar and were in fine condition. The spawls and mortar that had dropped on the haunches, as the main walls were carried above, made the arches exceptionally difficult to wreck. The total yardage moved was 16,500 cu. yd., of which 6,800 cu. yd. were stone walls, arches, old floors, etc.



Arrangement of Drag Line Skip.

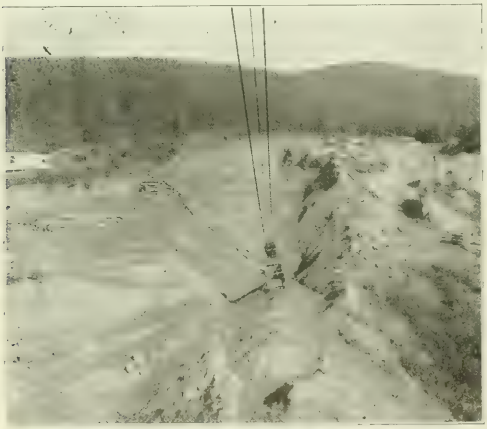
The Ferro Concrete Construction Co., Cincinnati, O., is the general contractor for this building. Tait & Nordmeyer Engineering Co., St. Louis, is the engineer and architect.

Portable Air Hoists Operate Disabled Derrick

Two small tugger portable air hoists were used to operate a large quarry derrick at a Montpelier, Vt., quarry while the regular swinging engine was being repaired. The two hoists were bolted side by side to 2-in. planks, which in turn were chained to two large blocks of granite. The lines from the hoists were led to opposite sides of the bullwheel, one being used to swing the derrick in one direction and the other to swing it back. This improvised arrangement kept the derrick in operation more than a week while the swinging engine was being repaired. In ordinary service one of the hoists is employed to overhaul the heavy cable from one of the derricks across the quarry pit, while the other is used in lowering steel and light loads into the pits. The above arrangement is described by Mr. H. L. Hicks in the Compressed Air Magazine.

Mining Manganese Ore with Cableway Excavator

A dragline excavator is being used at the Crimora mines at Crimora, Va., for excavating manganese ore from the pit. The excavator has a 1½-cu. yd bucket of the Schofield-Burkett type. This bucket dumps the material into a revolving bin having a capacity of 50 tons. From this bin the material is transported to the washer by means of an incline gravity railway, two 4-cu. yd. side-dump cars being used. From these cars it is dumped into the main storage bin at the head of the mill. The material leaving the bin passes over stationary grizzlies, spaced 3 in. apart. The fines or undersize goes back into a 25-ft. McLanahan stone washer, the oversize passing on to a moving grizzly also spaced 3 in. apart and deposited into a drag conveyor. This conveyor carries the large lumps to a slugger roll crusher. Here the material is crushed to 3 in. and sent into the log washers, making a uniform feed of 3 in. and under; leaving the logs, the material passes into a revolving screen, perforations 2 in.; the undersize passes into screen No. 2, perforations ¾ in. and 1 in. The oversize of No. 1 screen is elevated to a picking belt, where the silica and iron is removed and the clean ore goes over the belt into the ore bin. The oversize from No. 2 screen is elevated to a picking belt No. 2, following the same process as No. 1; undersize passing into screen No. 3, perforations 3/32 in. This screen acts as a slime screen, removing all of the slimes before the material is elevated to two sets of 4 compartment McLanahan stone jigs. Flow sheet is composed of two separate units, each side a duplicate of the other.



Crimora Manganese Mines, Showing Excavator and Pit.

It has been found through recent operations that a considerable loss of ore is entailed in No. 3 screen. Therefore, the management is planning an additional unit for further recovery. In connection with this unit it is proposed to install a Dorr thickener, by means of which approximately 60 per cent of the water may be reclaimed for further use. Also, the solids made by the thickener will be further treated in the additional unit.

The mill as designed and installed has a capacity for treating 1,000 tons of material per 10 hours. The plant as designed can handle over 100 tons of washed ore daily. A recent laboratory test of the material as shown up in the excavator gave an average manganese yield of 5.42. This yield has also been borne out by recent drillings covering the area tested of the known Crimora basin.

The main milling plant consists of buildings and bins, in three sections, 66x150 ft., in which the ore-bearing material is received at a 100-ft. elevation. The entire equipment is of the most modern and substantial character, all automatic and with individual electrical drives. In the powerhouse there has been installed 500-hp. boiler capacity, Corliss engine, generator, dynamos and auxiliary machinery. This is housed in a building 35x100 ft. In addition there has been equipped a modern machine shop, 30x60 ft., and other buildings.

A reservoir has been erected in the mountains having a storage capacity of 27,000,000 gal. of water. The water from this reservoir is conducted to the mill through a 6,000-ft. flume line under a 140-ft. head. In addition, another reservoir is now under construction with a capacity for impounding about 17,000,000 gal. of water. The mill as designed and when operating full capacity requires about 1,000,000 gal. of water per day, which, if no recovery of water were made, would insure maximum operations for nearly two months; this would extend through the most prolonged period of drought ever experienced in that section.

Revolving Bins and Searchlight Tower.

The refuse from the mill is conducted to the sedimentation basin, which receives the mill run-off and can handle 1,500,000 gal. of water per day.

The entire equipment involves an investment of some $200,000, which of course, does not represent the initial purchase price of the property. The Crimora property is owned by the Crimora Manganese Corporation, 15 Broad St., New York City. William L. Hogg is Chief Engineer and Manager.

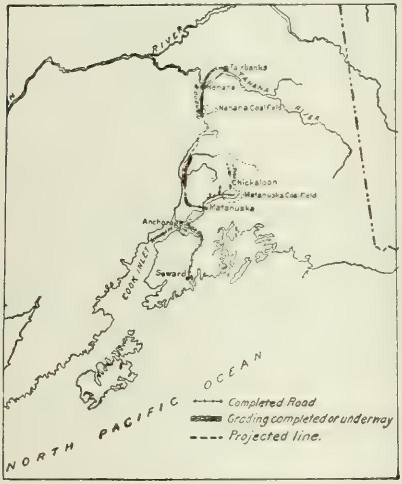
Land Reclamation in Texas.—The citizens of Texas vote on Aug. 21 on a constitutional amendment providing for the reclamation of overflow lands, irrigation of arid lands, drainage, etc. About 35,000,000 acres of land will be affected. The average present value of this land is $5 to $10 per acre. The average reclaimed value named by the State Reclamation Department is $125 to $150 per acre, these figures being based on actual production of lands that have been reclaimed.

The Secretary of the Interior has asked Congress for an additional appropriation of $4,000,000 for the Alaskan railroad construction to close a 30-mile gap on the main line from Tidewater at anchorage to Seward and open up the Matanuska coal field.

Progress on Government Alaskan Railway

Of the 1,000 miles of Government railway in Alaska authorized under the act of 1914, 150 miles are now in operation and 470 miles of main line from Seward to Fairbanks are under construction. The accompanying map, issued recently by the U. S. Department of the Interior, shows the construction progress to date. The primary purpose of this railway system is to develop the mineral resources of Alaska, particularly its coal.

The road taps two large coal fields, the Matanuska and the Nenana. The coal in the Matanuska field has been tested by the Navy and found to be excellent for steaming purposes. The Nenana coal was recently tested by the Bureau of Mines and found to be a fair grade of lignite. It is estimated that the supply in both of these fields is practically inexhaustible. By September of this year the branch line will be completed to the heart of the Matanuska coal field. Dredging is under way at Anchorage, the nearest tidewater to the coal fields, in order that deep draft ocean vessels may be loaded at the docks. When the gap, about 25 miles in length, along Turnagain Arm, between Anchorage and Seward, is completed, coal can be shipped from the latter port. It is planned to close this gap early in 1918.



Map Showing Construction Progress on Alaskan Railway.

The Alaskan Engineering Commission in charge of the railroad work is now using coal mined from the Matanuska field in the construction of the line. Construction work is being pushed as rapidly as possible, and it is estimated that at the present rate Matanuska coal can be delivered for the needs of the Navy and for general use on the Pacific Coast in the early summer of 1918.

The railroad is also being constructed southward from Fairbanks to tap the Nenana field, making the coal here available for the development of such mineral deposits as copper, antimony, and gold in this part of the country. Mining here is practically at a standstill, owing to the lack of suitable fuel. The Nenana coal will also be made available for use on the railroad locomotives and on the river steamers of the interior.

A 260 Ton Electric Locomotive

The first of the standard type of high-powered electric freight engine of the Pennsylvania R. R. has been placed in initial service on the electrified portion of the main line extending west from Philadelphia to Paoli, Pa. The important field of application of this locomotive will be hauling the heavy freight traffic of the road over the Allegheny Mountains between Altoona and Johnstown, Pa., including the Horseshoe Curve, a distance of about 40 miles. The traffic over this division is unusually heavy, amounting to as much as 300,000 tons a day. The grades are unusually steep and electrification will greatly facilitate the movement of freight tonnage over this grade. Eastbound trains of 6,400 tons weight will be hauled by one engine pulling and one pushing at a speed of over 20 miles an hour.

Standard Type of High-Powered Electric Freight Engine of P. R. R.

The locomotive is of the familiar side-rod type, built in one unit, with the cab extending over the two trucks. Each truck has six 60-in. driving wheels, and has mounted on each two induction motors. The two motors on each truck are geared to a spring-geared jackshaft, which in turn is connected to the driving wheels by means of the slide rods. Single-phase current is supplied from the trolley wire at 11,000 volts to the transformers which reduce it to a lower voltage. From here it is delivered to converter which in turn changes the energy into three-phase current for application to the induction motors.

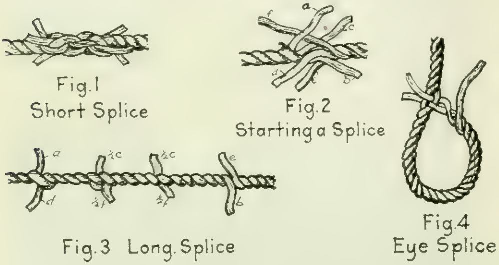
The weight of the locomotive is 260 tons and the length is 76 ft. It is designed for normal running speed of 20.8 miles per hour, which is considered sufficiently high for the mountainous country, steep grades and heavy traffic to be encountered. A speed of 10.3 miles per hour, obtained by connecting the motors in "cascade" is used for slow movements, such as around the yards. The control is effected in a very simple manner by the use of water rheostats. With such success has this control been worked out, power can be applied so gradually as to enable the engine to start a long train without any jerks.

The locomotive is the joint design of the Pennsylvania R. R. Co. and the Westinghouse Electric & Manufacturing Co. The mechanical parts were erected at the Juniata shops of the railroad company at Altoona, Pa., and the electrical equipment built at the East Pittsburgh shops of the Westinghouse Co.

How to Splice Rope

The following directions for making splices in ropes are taken from a circular issued recently by the National Safety Council:

Short Splice (see Fig 1). First unlay the strands of each rope to a convenient length and butt together the rope ends (see Fig. 2) having each strand of one rope lie between the two consecutive strands of the other rope. The strands of one rope should be drawn along the second rope and grasped in one hand. Then weave the free strands of the second rope in the strands of the first rope, working in a direction opposite to the twist of the rope. Similarly weave the strands of the first rope, and after continuing the process as far as desired, cut off the loose ends of strands. By cutting out a few fibers of a strand each time it is worked through the rope, the splice may be neatly tapered. The splice should be made smooth and compact by rolling under the foot or a board.



Figs. 1-4.—Methods of Making Splices.

Long Splice (see Fig. 3). Butt the rope ends together as described in making short splice (Fig. 2). Unlay a strand of one rope to any desired length and lay in its place the nearest strand of the other rope, tying or tucking in the ends. Do the same with another pair of strands in the opposite direction. The remaining pair of strands is split so that half is laid in one direction as above, the other half being laid in the opposite direction.

Eye Splice (see Fig. 4). Unlay the end of rope to a convenient length. Pass a loose strand between strands of the rope at a point that will make the proper sized eye. Pass the other loose strands between adjacent strands of the rope and proceed as in making a short splice.

St. Louis Items

J. B. Newman, Waverly, Ark., has some wheeler and wagon work to let.

Dudley Smith got in on a nice grading contract the other day at Benton, Ill.

McMillen Contracting Co., Sawyerville, Ill., want to rent a grader for a short time.

Frank McCabe is doing bridging on the Gulf, Mobile and Northern R. R. at Jackson, Tenn.

H. E. Hewitt is finishing his grading job near Creal Springs, Ill. Wants work for his 7-team outfit.

Lameroux Bros. expect to finish their State Aid water-bound macadam road near Bloomington, Ill., shortly.

Cameron, Joyce & Co. have their outfits at work on 39 miles of State Aid road work in Northern Illinois.

L. Gray, 4422 Gibson Ave., St. Louis, Mo., will have his 9 teams, engine and grader outfit idle within a week.

John Higgins, 3929 Morganford Road, St. Louis, Mo., wants to put two teams to work on a grading job in this neighborhood.

Maney Bros., Oklahoma City, Okla., were awarded 62 miles of grading between Owen and Fairfax, Okla., by the Santa Fe. R. R.

T. W. Blythe of Blythe Bros. was here the other day hunting work for their 25-team outfit that will be idle at Tama, Ia., in a few days.

R. M. Davies, 727 Walton Ave., St. Louis, Mo., has finished his grading job in Southern Illinois. Is in the market for work for his 10-team outfit.

J. W. Skinner, an old time contractor, is open for a situation to take charge of a contractor's outfit, grading or bridge work. Wood River, Ill., will catch him.

Contractors when in want of work or labor for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Dalaware St., Kansas City, Mo.

Stresenreuter-Cotton & Co., 860 Old Colony Bldg., Chicago, Ill., have taken some work from the Walsh Const. Co. on the Illinois Central R. R. near Dawson Springs, Ky.

Mulvill Bros., Alton, Ill., were awarded the contract for building an extension to the street car line in Alton, Ill. They also have several nice pieces of grading to sublet in Alton.

Clarence Mitchell, Supt. in charge of Smith & Hannan's work at DeWitt, Mo., reports this job finished and moving one of their shovel outfits on to a new job of the Wabash R. R. at Meredosia, Ill.

The J. J. McCaughey Co. were awarded another 40,000 yards of machine work on the Burlington R. R. near West Frankfort, Ill. They went to sublet this piece. Will furnish transportation on the Burlington R. R. east of Missouri River.

L. J. Smith Const. Co., Commerce Bldg., Kansas City, Mo. were awarded the contract for 17 miles of new work on the Illinois Central R. R., between Dawson Springs and Providence, Ky. They have some steam shovel and rock work to let on this job.

C. L. Dolman, Topeka, Kansas, has 150,000 yards of machine, wheel and drag scraper, also fresno work to sublet on the Santa Fe R. R. between Floyd and Camden, Mo. Dolman has opened a branch office in Floyd, Mo., where he will have a representative to show contractors over this work.

Smith & Hannan were awarded three nice pieces of work on the Wabash R. R. at Decatur, Meredosia and Forrest, Ill. Can use several team outfits on this. Free transportation over Wabash R. R. for outfits and labor. This firm also has some elegant steam shovel work on the Illinois Central R. R. in Kentucky to sublet with free transportation over the Illinois Central R. R. Address them Boatsman Bank Bldg., St. Louis, Mo., or Commerce Bldg., Kansas City, Mo.

A. B. KOENIG.

Personals

George Gerhard has been appointed city engineer of Anacortes, Wash.

Walter W. Marr has been reappointed chief highway engineer of the Illinois State Highway Department.

F. B. Tapley, heretofore assistant engineer Canadian Government Railways at Moncton, N. B., has been appointed assistant engineer of main maintenance, all lines.

T. J. Wilkerson, formerly division engineer of the Department of Public Works of Pittsburgh, Pa., has been appointed Chief Engineer of the Penn Bridge Co., Beaver Falls, Pa.

T. J. Wright has opened offices in Seattle, Wash., where he will engage in a general consulting practice. Mr. Wright, formerly was county engineer of Benton County, Washington.

J. F. Deimling, assistant chief engineer of the Michigan Central Ry., will act as chief engineer during the absence of George H. Webb, who has been commissioned lieutenant-colonel in the 6th Engineer Regiment, National Army.

Henry G. Lehrbach, C. E., has been appointed and confirmed assistant civil engineer in the navy. Mr. Lehrbach was appointed from civil life, one of twenty-five such appointments made by the President on June 21. He is a graduate of the School of Engineering of Cornell University and for a time was connected with state highway work in New York, resigning in 1915 to join the engineering staff of the Dunn Wire-Cut Lug Brick Co. of Conneaut, O. He was Division Engineer of the Atlanta, Ga., division for a time, but later was transferred to the district having headquarters at Columbus, O., a position he was filling when he received his appointment to the civil engineering corps of the navy.

Obituaries

R. J. Moscrip, formerly chief engineer of the Nashville & Knoxville R. R., died July 1st, Nashville, Tenn., aged 74 years.

Zachary Taylor Herndon, Civil Engineer and Railroad Builder, died at Akron, Ohio, June 25th, aged 71 years. He spent fifty years in the practice of his profession, mostly on surveys and construction of railroads, and served as Chief Engineer during the building of many roads in the West Middle States.

Industrial Notes

J. H. McKelvey has been appointed sales manager of the Laclede-Christy Clay Products Co., St. Louis, Mo., vice H. K. Lackland, resigned.

The Medora Shale Brick Co., Medora, Ind., of which N. V. Trautman is president, has joined the family of licensees of the Dunn Wire-Cut Lug Brick Co., of Conneaut, O. The addition of the Medora company gives the Dunn company 46 licensees, operating 71 plants in 12 states.

J. H. Flynn has been appointed manager of the Bucket Department of the Blaw-Knox Co., Pittsburgh, Pa. Mr. Flynn is a graduate of Boston Tech, of the class of 1905. After graduation he went to Panama as a draftsman for the Isthmian Canal Commission; was later made Chief Draftsman, and shortly after, Mechanical Engineer, serving the Government through the period of heavy construction until 1911. During the past six years Mr. Flynn has been connected with the Lines-Flynn Co., of New York City, handling a general line of contractors' equipment.

The Walter A. Zelnicker Supply Co. and affiliated companies are now represented in the Birmingham district by Thomas A. Hamilton, who for the past fourteen years has been connected with the Crane Company, prior to which he was superintendent of the East St. Louis plant of the Zelnicker Car Works. Mr. Hamilton will have charge of both buying and selling in the southeastern territory. Mr. Hamilton's office will be at 1018 Woodward Bldg., Birmingham, Ala. The Zelnicker Co. also has secured the services of W. H. Dayton as City Salesman at St. Louis. Mr. Dayton was formerly with the Railroad Supply Co., Chicago, Illinois, as Secretary and Purchasing Agent; also their eastern representative for five years. He came to St. Louis seven years ago representing the same firm and that of the Chicago Signal & Supply Co., and the Elyria Iron & Steel Co., manufacturers of signal and track maintenance materials.

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HALBERT P. GILLETTE, *President and Editor.* W. H. FOGERTY, *General Manager.*

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Heat Radiation and Conduction Losses in Buildings

In our last Building and Structural monthly issue an article by the editor gave formulas for calculating heat losses through walls and windows by conduction and convection. The statement was also made that to the conduction and convection loss must be added the loss by radiation from the outer surface. In a subsequent issue a full discussion of radiation will be given, but it may be well now to state that for building walls and for windows the heat loss by radiation is practically equal to the loss by conduction and convection.

The formula for radiation loss, where the external temperature is low (that of the air) and where the temperature drop between the surface and the air is small is:

$H = 1.09e\ (t - t_0)$
$H =$ B.t.u. per square foot per hour
$e =$ emissivity or coefficient of radiation.
$t =$ temperature of the surface in degrees Fahrenheit.
$t_0 =$ temperature of the external air.

The value of e is about 0.9 for glass and is but slightly different for brick, stone, concrete and wood.

In many books the word "conduction" is carelessly used to include radiation; and in some books the word "radiation" is used to include conduction. A careful writer who fully understands heat transfer phenomena uses the word radiation to denote only that part of the heat that is transferred by radiant action from the surface, and does not include that part that is removed from the surface by the action of the currents of air. In view of the carelessness of writers as well as of many experimenters it is important to know the exact method by which a so-called "conduction" loss was obtained. If on the side of the solid exposed to the lower temperature there was water, then there could have been no radiation; and in that case the "coefficient of conductivity" does not include radiation. But if, in the test, the outer surface was exposed to the air, it is altogether likely that the experimenter included radiation in his derived "coefficient of conductivity." Even in such a carefully written and recent book as "The Mathematical Theory of Heat Conduction" by Ingersoll and Zabel, the blunder is repeatedly made of using a "coefficient of conductivity" that includes radiation.

For more than a century problems of heat transfer have occupied the attention of physicists and engineers, and a vast amount of data has been accumulated. Nevertheless, no book gives even an approximately complete discussion of the seemingly simple problems of heat transfer through the walls of buildings, to say nothing of some of the more complex problems. The book above quoted is good in some respects, but its failure to discuss radiation makes it quite misleading. Preston's "Heat" is somewhat better because radiation is discussed, but it fails to discuss the combined heat loss by radiation and convection.

Considering the innumerable problems involving heat transfer it is little short of amazing that most engineers are still in such a general state of ignorance. Not a single "engineer's pocketbook"—including Kent's—is a trustworthy guide.

How Many Practising Engineers Study Physics

Civil engineering, and particularly structural engineering, is based largely on a knowledge of physics. The fundamental theory of elasticity, for example, has been developed by mathematical physicists. The theory of heat transfer is also the work of mathematical physicists. Engineers, it is true, have occasionally been physicists of renown. In fact the eminent early engineers, of whom Rankine was an excellent type, were often even more familiar with "pure science" than with "applied science."

In recent times, and particularly in America, civil engineers have generally regarded pure science as a study to be dropped immediately after graduation. We fear that this tendency has been carried to extremes. Certainly American civil engineers have made few noteworthy additions to the fundamental theory of design of structures during the last generation. Is it because all that physicists have discovered is now used as effectively as possible by civil engineers? If anyone is inclined to give an affirmative answer, let him first go to any good scientific library and spend an hour or two each night for a week voyaging in the sea of physical literature. We venture to say that after such an excursion there will be few who will assert that they have seen no new facts or theories that might be used in engineering practice.

Not long ago the editor made such an excursion out of the beaten lanes of engineering—following a habit formed years ago while a college student—and after a few hours' study he came upon several physical facts that were obviously applicable in civil engineering. Incidentally he read some physical tests that were made 77 years ago which, had they been carefully considered by any engineer, might have led to the invention of the "gas-filled" or nitrogen incandescent lamp long before it was invented. We refer to an experiment by Dr. Andrews (Proc. Royal Irish Academy, 1840), by which it was shown that a platinum wire heated by electricity is less brilliant in a vacuum than in the air. We venture to say that had Edison known this fact, he would never have rested content with his original carbon filament in an air-exhausted bulb.

Engineering is the application of science. How many of us are seeking to advance engineering by searching the records of physical tests and by studying the theories of physicists? Not a great number, we fear.

Which Is Preferable: Engineering Government or Representative Government?

Never were the defects in "representative government" more apparent than now. Wrangling Congressmen have been obstructing the passage of the food bill for weeks. Those who represent agricultural districts are fearful that if the power of price regulation is placed in Hoover's hands, their constituents may cease making exorbitant profits. Those who represent city districts are mainly against the granting of a power that will curtail the supply of beer for their constituents. And so it goes, just as it has been going for generations in Congress—district against district, interest against interest, with unity in but one matter, namely, that all will fight to the last ditch against selecting an impartial arbitrator.

In Hoover, the mining engineer, the public sees a man not only competent to handle the food problem, but entirely free from allegiance to any class or section in America—apparently an ideal administrator and arbitrator. But the nation's representatives are not in search of such a person. Theirs is the time-dishonored practice of "log rolling" and trading with one another, the petty political bargaining amid a welter of words, threats and abuse—the sort of thing we have come to know as "politics."

Perhaps it is well that the nation is now getting a choking dose of this nauseating medicine. It may serve to accelerate a long-needed change in our form of government, whereby we shall pass from sectional and class representative government to a government of engineering management.

The "city manager" form of municipal government is typical of engineering management of political affairs. The aldermanic and mayoral form of government is typical of the representative form, which is doomed to extinction in all our cities. For precisely the same reasons that representative government is an economic failure in our cities, it is a failure in our separate states and in the United States.

While it is true that the quality of any government depends on the men in power, it is equally true that it is also dependent on their personal disinterestedness in the effects of their actions, further than as it redounds to their credit to secure the maximum efficiency or economy for the community as a whole. This last named condition is ignored by the advocates of the continuance of our old forms of government, and they "play up" the other factor, namely, the quality of the men in office. Those who believe that engineers should be selected for public office on the score of quality of character and desirable knowledge might accept any challenge to debate on this matter, but they would err grievously if they did not insist that quality is not the only essential of an officeholder, for freedom from allegiances is also essential.

Civil engineers should take increasing interest in political affairs, and always with the ultimate aim of substituting engineering government for representative government.

What Can Be Done to Restrict the Use of the Title Engineer?

One of our readers has sent us a newspaper clipping headed: "Engineers Likely Will Lose Jobs." The "engineers" referred to are marine enginemen. Our reader pertinently asks why these men should be called engineers.

In England the old word "engineman" is used to designate those who operate engines. But in America it became the early practice to call enginemen engineers. In the absence of organized societies of engineers no adequate protest was made against the usurpation of this professional title by mechanics; so now it will be no easy matter to effect a change. Nevertheless, we believe that engineers should use their individual as well as their collective energy to bring about a restriction of the word "engineer" to those who are professionally entitled to it.

We suggest that our readers can individually aid in this plan by never failing to write to the editor of a daily paper in which enginemen are spoken of as engineers, asking the editor to assist in maintaining the original titular distinction between these two classes of men.

We also suggest that societies of railway engineers should try to persuade railway officials to drop the use of the word engineer as a designation of locomotive drivers. The brotherhood of locomotive engineers might object to an attempt to change their title, but it is likely that even they would not insist upon retaining a name that leads to confusion. Certainly many of them have already ceased automatically to be "locomotive engineers" and have become "motormen" on "electric locomotives."

One of the desirable—though perhaps not immediate—results that will flow from the passage of state laws licensing engineers will be restrictions placed upon the use of engineering titles. To our way of thinking, this result would alone justify the passage of licensing laws.

In writing articles and books it has long been the practice of the editor never to apply the word engineer to an engineman. Similar care on the part of other engineers will aid in restoring the ancient and reasonable distinction between these two names.

Outlook for Building Activity

Although the immediate effect of our entering the world war in April was a decrease of about one-third in building permits in cities, it is becoming evident that this was more the result of a war scare than of any well reasoned conclusion that it would be economic to reduce building operations.

Mr. S. M. Fechheimer says editorially in the June issue of "Modern Building":

> Our country is underbuilt in practically every direction we turn. In our cities there are not enough residences, as is proven by the uniformly high scale of rentals. Our manufacturers have not been able to keep up with the demand for products for both domestic and military uses, and will require increased facilities. This means more buildings. The conditions

> among railroads are so apparent to everyone as to require very little comment. Our transportation facilities are woefully inadequate, and must be expanded widely to take care of our country's needs. This will mean not only new equipment but new buildings of all kinds.
>
> In commercial life, hundreds of new buildings will be required. Warehouses in great number will be needed to store goods of all kinds, as merchants and supply men cannot depend on hand-to-mouth buying, but must store their goods when they can get them. This applies not only to food supplies, which must be conserved as never before, but also to all general lines of merchandise.
>
> So we say with utmost confidence to the building world—cease talking and worrying about what are the prospects for building. Instead, turn your energies to the marshalling together of your building forces and equipment. Be prepared to be as busy as you care to be, and, above all, arrange your organization to handle the maximum of work with the utmost efficiency, as one of your most difficult problems will be to secure adequate and competent labor.

What Are the Engineering Colleges Doing to Recruit Their Classes?

Many engineering students will join the army, and so will many young men who had planned to enter engineering colleges. Who will take their places? Are we to witness a marked falling off in engineering classes? What is being done to prevent the falling off that seems imminent?

At Washington the other day, in an address to the Society for the Promotion of Engineering Education, Secretary of War Baker said:

> Nobody knows how long this war is going to last, but we do know that when the war is over the rehabilitation of a stricken, if not paralyzed civilization, is going to be a long-drawn-out and uphill task and there will be need on every hand for trained minds, for trained and schooled men. The day of the engineer will be indeed the big day.

Every one, we believe, will agree with this statement, but what are the engineering colleges doing to build up their classes? Now is the time for an intensive publicity campaign to recruit freshman engineering classes; but we see no publicity at all. When will our colleges adopt business methods?

We Need an Engineering Billy Sunday in Our Midst

Several engineering societies, including the American Society of Civil Engineers, have canceled their annual meetings. We have previously questioned the wisdom of such action, and are glad to observe that we are not alone in believing that technical societies should not lessen their activities. Dr. Colin G. Fink, president of the American Electro-Chemical Society, says:

> Meetings of scientific and technical societies have ever served a great stimulus for their members and have been a "clearing house" for many of the best thoughts and ideas of our professional men.
>
> Let us follow the good example set us by England. Let us encourage rather than discourage the holding of scientific meetings in these war times. When England found herself confronted with a very serious shortage of sulphuric acid, glass, dyes, electrodes, brass, furnaces, etc., the scientific societies arranged symposiums on these subjects and not only invited all of the members to attend but, further, urged those factory men who were not members to come to the meetings to give their views and experiences and to learn all they could in return.
>
> Just as a large business corporation depends upon the organized effort and efficiency of the several units and departments, so does our government, now more than ever, look to the organized concerted effort of its large engineering bodies for quick and efficient results. Let us continue holding our meetings and hold them more frequently than ever before.

Isn't the very suggestion that an engineering society should "shut up shop," even temporarily, a tacit admission that collective engineering activity is of no great importance? If engineering methods do advance efficiency, is there not more reason for them now than ever? When has the nation had a greater need of efficiency than during these days?

Come, let us civil engineers collectively arouse ourselves. We have too long meandered our professional paths in single file. We need to get together and to stimulate one another, now more than ever. There is not half enough enthusiasm, nor a quarter enough imaginative vision, in us as a class. We need a few engineering Billy Sundays in our midst, and we need them now.

Relative Efficiency

To the Editor: Efficiency is only relative. The writer had this very forcibly presented to him by visits to two very dissimilar construction jobs in one week. One was an aviation camp where everything was subordinated to speed. The purchasing department was instructed, regardless of cost, to telephone if possible, wire otherwise, only use the mails if unavoidable. Material came by express or parcel post. Promises of delivery had to be kept or future business lost. Of course orders were duplicated and express charges ran into big figures. The organization worked at high pressure and had to be highly paid. There was considerable expected, but a camp housing 90 aeroplanes, repair shops, workmen and with buildings for officers and men, was built in a month at a cost of nearly a million.

The other job was a much bigger one. Heavy equipment was to be used. Several years would be taken in executing this work. Careful attention was given to buying even the minor details of the plant and equipment. An older and larger and more permanent organization handled the work. Delays did not appear to be serious. But in times of rapidly advancing prices this careful consideration resulted in options being lost, because the quotations had to be studied by several men. Even when accepted in time, delivery dates were advanced considerably and frequently out of proportion to the time taken in consideration. These disadvantages have to be balanced against the more perfect organization.

Unit costs under both systems are not available and might be of small value in any case. Personal observation would lead to the conclusion that the high pressure under which the aviation camp was built made for economy in labor which offset very considerably high transportation costs, etc. In the heavy construction job the careful consideration of costs resulted in some losses and there was considerably more "red tape."

Both organizations were efficient. The two could not have been interchanged, but each could learn much from the other's methods. The interesting fact about the whole experience was the conviction that the two organizations were on a par as regards actual efficiency, considering results and time available.

The government will expend over $50,000,000 for terminal storage areas at or near seaboard. Each of these areas probably will be at least 2,000 acres in extent.

Construction and Structural Features of Cantonments for New National Army

Construction is now under way on the 16 cantonments for the new national army. The main features of these training camps are outlined in the following notes. It should be understood, however, that many of the statements are general, and may not apply to the work at all of the camps.

Location.—It was necessary to begin the design of the buildings before anything was known about the location of the camps by the Quartermaster Corps. The camps were located originally by the department commanders, whose recommendations were reviewed by the General Staff. The General Staff reported its decision regarding each of them to the Secretary of War, who made the final selection. While the sites were being chosen in this way the Quartermaster General's staff was designing a typical cantonment for each of the 16 divisions, planning the buildings, estimating the general sewerage and water requirements, and doing everything that could be done before a map was available. Just as soon as the site was selected an experienced civil engineer engaged for this preliminary work made a topographical map of it, procured data concerning the sources of water supply, the facilities for sewerage, the railways in the vicinity and the roads. With this map it was possible to begin the general planning of the camp, and as soon as this general plan was made the execution of the work was undertaken by the constructing quartermaster in charge, who has authority to engage a consulting engineer and a water and sewerage specialist if they are needed. For the surveying and similar work, the engineering force of the contractor is utilized as fully as possible. The constructing quartermaster also has an auditor with an accounting staff, as the contractor works on the cost-plus-percentage system and it is necessary for the government to have complete knowledge of all items of cost entering into the work.

The general grouping of the cantonment buildings at any site is controlled by two classes of conditions: (1) The military requirements; (2) the cost of installation and convenience of operation. It has been considered desirable to have some open and fairly level land for drilling, but where this would entail a large additional cost at any camp the requirements have been reduced to a minimum, and some of the clearing will be done by the troops themselves. The preliminary work of fitting the typical plan to the topography of any camp was reviewed in the Quartermaster General's office. No attempt was made to do more than indicate the location of the main buildings, and the constructing quartermaster is responsible for the final adjustment. So far as possible, brigade formations have been preserved, and no building for one of the primary units has been interposed among those of another primary unit. The buildings for the animals are generally separated from those for the men by the main trucking road. In all cases special attention has been given to providing fire breaks, usually by constructing wide roads.

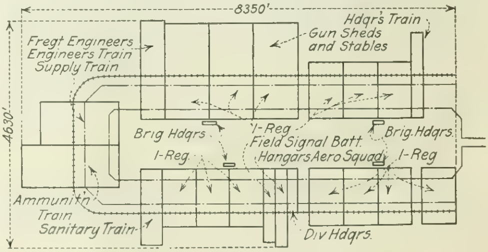
General Order of Work.—The problem of transporting the materials for these cities at the same time the railways have to meet many other exceptional demands, is serious. It has therefore been directed that the construction be undertaken by successive steps, in order that the railways may not be unnecessarily pressed in making deliveries. The first work is the construction of the roads and railway sidings absolutely necessary to carry out the building program. While these are under construction the contractor must provide temporary quarters for his own staff and laborers, numbering several thousand.

The first of the cantonment buildings to be constructed are the barracks, including the kitchen and mess facilities, lavatories, officers' quarters and store houses, and whatever works are necessary for water supply and sewerage.

The arrangement that has been made for providing lumber for the various cantonments, is as follows:

Through the Lumber Sub-Committee of the General Munitions Board, representatives of the big lumber associations of the country were assembled in Washington and agreed upon a price for lumber for these cantonments, this price not to exceed an average of $20 per thousand. It is understood that there are many independent mills not represented in the associations, so to meet the demand from independent mills, this arrangement has been made: The letter of instructions to the contractor is to the effect that he will place at least 75 per cent of his lumber bill with the committee, and that he may shop for the remaining 25 per cent among the independent mills within his district.

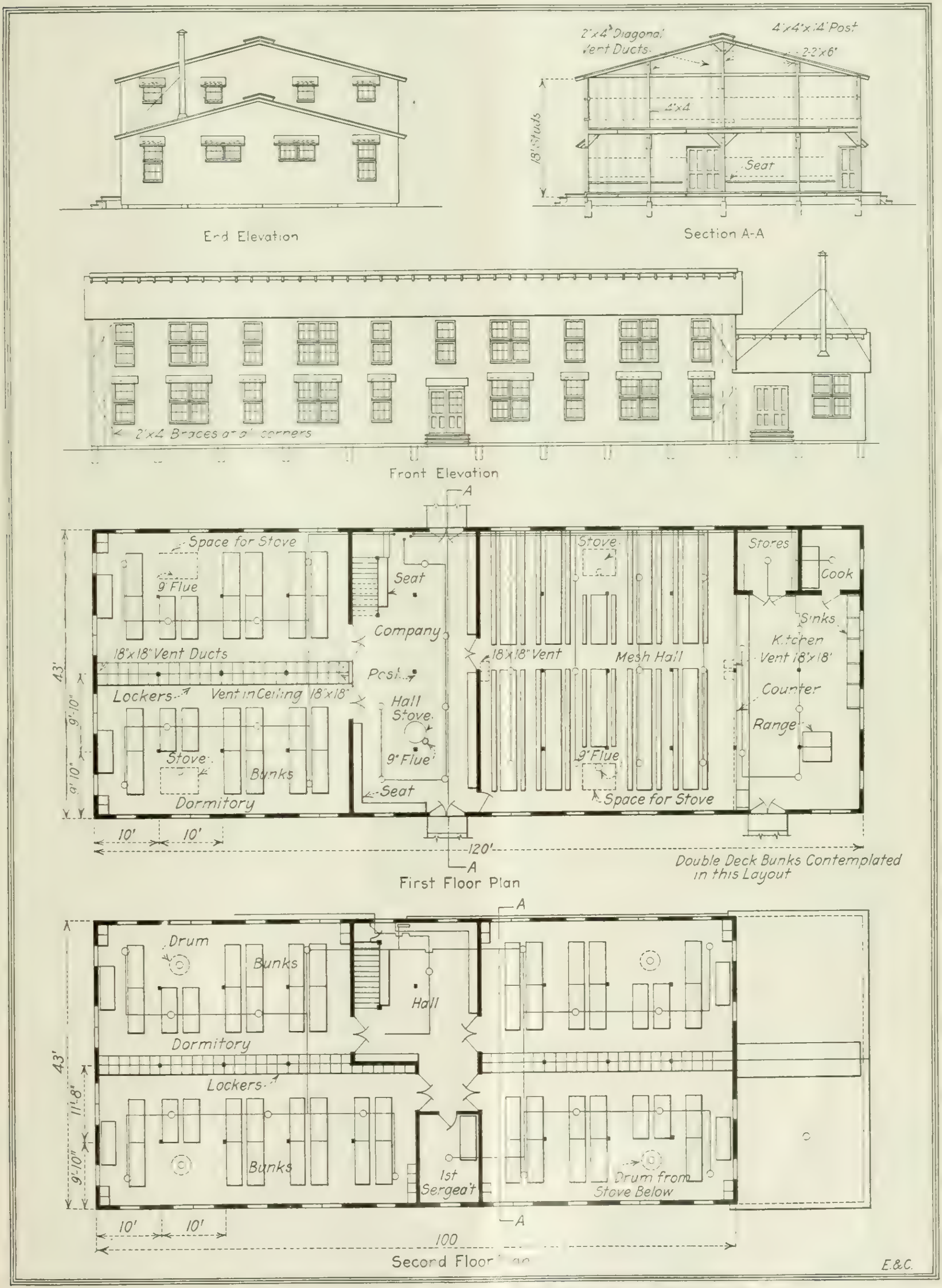
When a contractor is awarded a contract for any given cantonment he is given a letter which directs him to take up the matter of the purchase of lumber with the lumber committee. This committee has districted the United States and will recommend to the contractor that he purchase the lumber from such mills of these associations as can most economically handle the matter, both from the point of view of railroad facilities and the time of delivery. This arrangement was found to be absolutely necessary as a preventive measure in the matter of competition, and to regulate lumber prices.



Typical Layout of Standard Cantonment.

Procuring Materials.—A statement of building materials which can be furnished by each dealer in the territory where each camp is located, the prices and the rates of delivery were secured from the advisory committee of the Council of National Defense. These statements concerning each camp are furnished to the constructing quartermaster for the guidance of the contractor. It is not expected they will locate everything the contractor needs, or that the contractor will hold up work to wait for deliveries of material from distant places. In fact, the contractor is expected to buy in the local markets the small tools, minor equipment and materials needed for speed, and the constructing quartermaster is ordered to give to the contractor at all times "every assistance calculated to expedite his work and relieve him from hampering restrictions of any sort."

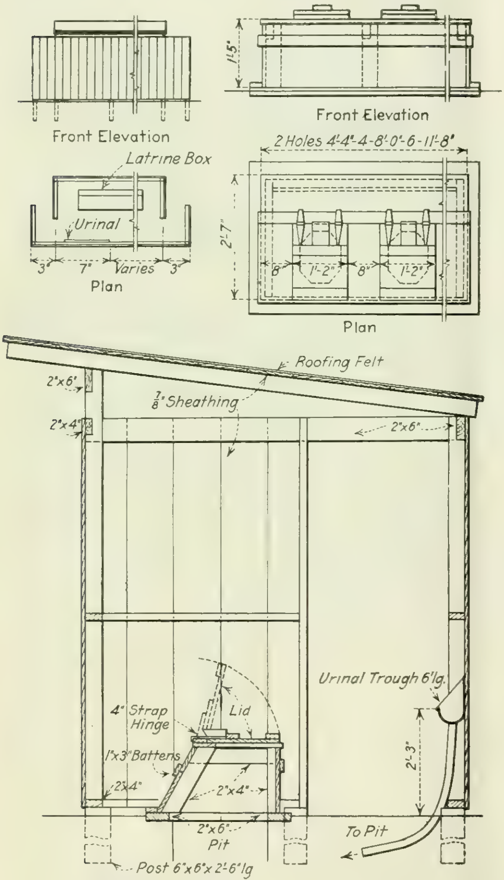
While the preliminary estimate of materials for a



Plans for Company (167 Men) Barracks for National Army Cantonments.

cantonment was made in the Quartermaster General's office, the final detailed schedules are made by the contractor.

Transporting Materials.—The contractor furnishes to the constructing quartermaster certificates of the number and classes of cars needed to transport the materials for the camp, the approximate dates on which the cars are required, the points of shipment and the destination, and copies of these certificates are sent to the Commission on Car Service of the American Railway Association. The government then furnishes a waybill envelope for each car, which will indicate to every yardmaster and trainman that the car is engaged in national service and must be moved without interruption. A representative of the railway on which the camp is located is stationed at the camp to expedite deliveries.



Section Thru Enclosure Latrine Box and Urinal Trough

Details of Latrines for Cantonments.

Labor.—The union scale of wages prevailing at the locality on June 1, 1917, is adopted at each camp. The regulation of hours of work and overtime pay is fixed by agreement between the constructing quartermaster and the contractor in accordance with conditions prevailing in the section where the camp is located. Special endeavor is made to impress upon the workmen that the construction of these camps to meet a national emergency should be marked by the temporary slackening of regulations which hamper rapid production.

Headquarters' Supervision of Work.—The constructing quartermaster for each cantonment has had extensive experience in handling large building works. Some of them are members of Quartermaster Corps and the remainder are members of the Officers' Reserve Corps who have won recognition as construction superintendents of the first rank. In case the constructing quartermaster is in the Officers' Reserve Corps, an officer of the regular army has been assigned to the cantonment to look after the military and administrative work in accordance with the regulations of the War Department and relieve the constructing quartermaster of those duties for which his civilian experience did not train him.

The constructing quartermaster has very large powers, for it is believed that the speed of the work will be increased by giving him practically complete authority, except as the general instructions issued in Quartermaster General's office control his management. It is necessary, of course, for the Washington headquarters to have full knowledge of the conditions at each camp, so a daily telegraphic report is made on each of the principal features of the work, a written weekly report gives a comprehensive view of conditions, and weekly graphic charts show the progress in the delivery of materials and the construction of each class of structures.

Fire Protection During Construction.—The prevention of fire in these wooden cities during construction is a very important matter and stringent regulations have been issued to minimize the risk. All brush, rubbish and dry grass must be burned where building materials are to be stored and for a distance of 300 ft. around all storage yards and building sites. As soon as materials arrive, water casks and pails are placed where they will be convenient for use in extinguishing incipient fires and a continuous fire patrol is established. As soon as fire apparatus is received fire companies are organized.

Among the more important fire regulations during construction are the following:

Smoking is prohibited wherever building construction is carried on or material is stored. Certain areas are designated where workmen may smoke at noon and smoking is permitted in a few buildings where constant watch is maintained. Open fires on or near building sites are prohibited. All rubbish about buildings is collected daily and removed to a place where it can be burned safely.

No open-flame lights, including candles, may be used in buildings, and to aid in enforcing this regulation the kits of plumbers, steamfitters and such mechanics are inspected before they are permitted on the job. Gasoline furnaces and torches must be kept in tool boxes or shanties outside buildings, and not more than three 5-gal. cans of gasoline are permitted on the job. The use of charcoal for heating soldering pots is prohibited. All tar kettles and lead furnaces heated by wood fires must not be placed within 50 ft. of buildings or lumber.

Boilers and internal combustion engines must be placed in detached iron-clad buildings. Boilers must not be set on wooden frames or platforms and stacks into which engines exhaust must have screened tops. Power-driven wood-working machines must not be operated in buildings under construction or in sheds within 20 ft. of such buildings. All electric wiring, even for temporary use, must conform to the National Electric Code.

Water Supply.—The minimum water supply for a cantonment has been fixed at 55 gal. per capita daily, equivalent to from 2,000,000 to 2,500,000 gal. per day for camps of 36,000 to 45,000 men. These quantities include the water required for animals and miscellaneous uses. The pumping units, if any are needed, are at least four in number, the smallest of a capacity of 750 to 1,000 gal. per minute each. The water works are designed to furnish water, on 3 minutes' notice for a period of 1 hour, at 2.85 times the minimum rate.

The distribution system is designed for pressures of 60 to 85 lb. Machine-wound wood-stave pipe is used in each cantonment with about 50 tons of cast iron pipe for curves and other special requirements and about 50 tons of cast-iron specials. In addition considerable cast-iron pipe is used to bring water from a distance to certain of the camps, as at Columbia, S. C., where the government will use 4,500 ft. of 16-in. pipe and the city will lay 15,000 ft. more.

The water is procured from the cheapest available source of satisfactory character. In some cases it is bought from existing water works and in other cases independent plants are constructed for the exclusive use of the camps. Storage is generally necessary to meet the peak-load requirement for an hour's draft at the rate of 156¾ gal. per capita daily. Either elevated storage capacity of at least 300,000 gal. is provided or a reservoir of at least 1,000,000 gal. from which water can be pumped directly into the mains.

The design of the typical water works system has been controlled by a desire to reduce the cost to the lowest amount compatible with an ample supply. In order that the capacity of the system may not be overtaxed, all waste will be stopped and certain regulations will be enforced.

Sewerage.—The sewerage system of each cantonment is designed to remove house sewage only, and no surface water is admitted except at a few places, where silt basins are provided. The kitchen plumbing includes grease traps. If 6-in. pipe is unavailable at any camp for kitchen connections 4-in. pipe may be used for them, but all other house connections are 6-in. The trunk sewers are designed on the assumption that the maximum flow in them at any time will be the maximum flow from one brigade plus the normal flow from all other units. The maximum flow of one regimental unit is taken at 1.5 cu. ft. per second and the normal flow at 0.5 cu. ft. per second. A brigade of three regimental units will therefore furnish a maximum of 4.5 cu. ft. per second by this assumption, and the remaining regimental units will furnish 0.5 cu. ft. for each. The desirable minimum grade is that which will give a velocity of 2 ft. per second when the sewer runs full, but a velocity of 20 in. is permitted in special cases. Special joints are required in wet ground and wooded areas. Manholes are required at intervals of 300 to 500 ft. The sewerage systems of the 16 cantonments, exclusive of outfall sewers outside the camps, will require about 12,000 ft. of 12 to 24-in. vitrified pipe, 297,000 ft. of 8-in. pipe and 1,052,000 ft. of 6-in. pipe.

Whenever practicable the sewage of a cantonment will be discharged into adjacent streams without treatment. Where treatment is necessary the sewage will be discharged in most cases into septic tanks holding about 10 gal. per capita. These are located at least 300 ft. from the nearest occupied building. These will be constructed of wood or concrete, as the constructing quartermaster shall decide. In a few cases intermittent sand filtration may be employed as a method of disposal, but in most cases where sewage is treated, the effluent of the septic tanks will probably be applied to trickling filters 6 ft. deep having an area of about an acre for each 30,000 persons. Settling tanks will be needed to clarify the effluent of the trickling filters, and, eventually, some method of providing for the disposal of the sludge from these tanks and the septic tanks must be provided, although this is not considered necessary for the present. It is further proposed to disinfect the effluent from some of these treatment plants by some chlorination process, if this seems desirable after a careful study of local conditions.

General Features of Buildings.—Each cantonment comprises about 1,000 unpainted timber structures of the simplest possible character. A few buildings used for storage and as garages and power plants will probably be metal-clad, and possibly corrugated iron siding and roofing may be employed for them. Where the buildings are supported on posts more than 15 in. above the surface of the ground and it is possible to keep the ground below them free from inflammable rubbish, the sides are not boarded down to the ground, which is done where the clearance is less than 15 in., except in the South, where it is necessary to omit this precaution against fire on account of the greater importance, from a sanitary viewpoint, of permitting a free circulation of air below the floor.

The 2-story buildings used for large barracks in the South will be heated by stoves on the lower floor, as is done in the Canadian cantonments. It is proposed to jacket the stoves so as to increase the circulation of air, and to carry the stovepipes directly up through the second story and roof. Drums will be installed in this stovepipe, with air jackets around them, for heating the second story. The smaller buildings in the South will probably be heated by small direct-radiating stoves. In the Northern cantonments it is probable central heating stations will be built and the building warmed by radiators.

Although no money is now available for lighting the buildings by electricity, it is believed this system will be used on account of the grave danger of fire if kerosene lamps are employed. The peak load for lighting is estimated at 600 kw. and the maximum power load at 300 kw. It is proposed to use two steel ranges in each large barrack and cook stoves in the smaller barracks. Probably most of the garbage will be burned in incinerators, but studies are being made to ascertain if the fats can be recovered at a cost which will warrant doing so.

Men's Barracks.—The barracks for the men are 2-story buildings 43 ft. wide and of different lengths, depending upon the number of men to be accommodated. At one end is a single-story kitchen, with a pantry and a sleeping room for the cooks. A long counter separates the kitchen from the mess hall, where all the men living in the barrack will eat. In the center of the first floor is a company hall, with doors leading outdoors on each side of the building and a stairway to the floor above. This company hall separates the kitchen from the two first floor dormitories. It was originally proposed to have the men sleep in double-deck bunks, such as are used in college fraternity houses and on large construction works, but the medical advisors of the Secretary of War reported so strongly against this that ordinary metal cots will probably be used and the size of the buildings increased to furnish the necessary space. The first story is 9 ft. high from the floor to the bottom of the beams of the second story. The second story of the larger barracks is divided at the center by a hall reached by the stairway from below and the sleeping room of the first sergeant. On each side are two dormitories or four in all on this story. The dormitories are separated by partitions so that the men in each are comparatively isolated from the others.

There is a ventilating opening running the length of the ridge of the building to which vertical vent ducts run from the floor below. The building has a large amount of window area, and the sash can be slid to one side to secure ventilation. The lavatories for both officers and men are small detached buildings.

Officers' Barracks.—The officers' barracks vary considerably in size and shape. Some are long single-story buildings with a kitchen at one end, then a mess room, and then a long hall down the center with rooms measuring 10 ft. 6 in. by 8 ft. 4 in. opening off it on either side, and an office at the further end. Other barracks are small single-story buildings, with a kitchen, mess room and two to four individual rooms, the largest about 10 ft. square. Other buildings are two stories high, with larger rooms shared by two officers, an office, mess room and kitchen. A few of the officers' barracks have no kitchen and mess room.

Amount of Lumber Required.—The construction of the barracks is slightly different in the northern and southern cantonments. This causes the amount of lumber for a southern cantonment, 16,314,000 ft. B. M., to be about 216,000 ft. less than that needed for a northern cantonment. These figures may be considerably increased, possibly 25 per cent, as a result of enlargements of the buildings to meet recommendations of the army medical officers. Furthermore, they will be increased by a large amount of lumber needed for stables, wagon sheds, post exchanges and essembly biuldings.

Handling Face Brick

Useful information on the buying and handling of face brick were given by Mr. H. E. Stringer of Hydraulic Press Brick Co. in a paper presented at the last annual meeting of the Association of Government Contractors, from which the following note is taken:

Brick when shipped from the factory are loaded in straw and are packed tightly in the car. In most cases, of course, except in the larger cities, the contractor buys f. o. b. car at destination, and has the bricks drayed. He should caution his draymen to keep at least a good portion of the straw with the brick when he takes same from the car, and he must have his teamsters pack bricks tightly in wagons. Upon arrival at the building site bricks should be placed on boards lying about 4 in. above the sidewalk or street so that the dirty rain water will not disfigure the bottom of the pile. This simple precaution is frequently overlooked, as is also the important requirement that press brick, particularly light shades, should either be stored under a shed or should be covered with tarpaulin. These simple precautions will eliminate considerable of the necessity for extreme cleaning down after the bricks are laid in the wall. In cleaning down our experience has been that the best solution is a mixture of muriatic acid and water, using one part acid and six parts water.

Rail Inclination, Wheel-Coning and Tie Plates

By F. H. FRANKLAND,

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There appears to be a considerable variation of ideas among railroad engineers concerning the matters of rail inclination, tie-plates versus rail-chairs, wheel-coning, and widening of track gage on curves; and it would seem that a proper standardization of these important features would effect considerable improvement and economy in track maintenance.

As regards the vertical versus the inclined rail—the vertical rail is a beam loaded eccentrically to its axis, the center of pressure on the base of rail being inside the center of the base. To illustrate: In Fig. 1, the rail has a circular contour on its head of radius R (say 10 in.), the standard wheel-coning being 1 in 20, and, therefore, the theoretical contact—disregarding compression—between rail and wheel is at a point inside the center of the rail head $\frac{R}{20}$, which, with a radius of 10 in. equals ½ in.

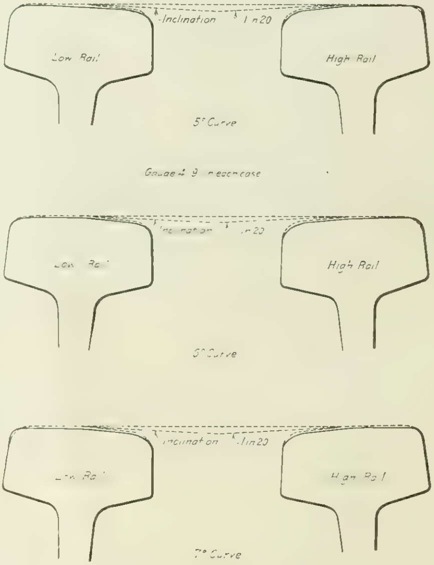

Fig. 1—Wear on Rail Laid Normal to Ties.

On straight track the wheel load, L, is vertical, and the horizontal reaction due to wheel-coning is $\frac{L}{20}$. If H equals 5 in., this action of the wheel is equivalent to a center of vertical pressure on the rail base $\frac{1}{20\text{th}}$ of the rail height nearer to its vertical axis than the center of contact on the rail head. This displacement of the center of pressure is due to the couple formed by the thrust on the top of the rail opposed by the frictional resistance at its base, $\frac{LH}{20}$.

In the case of a 5-in. rail with a circular top of 10-in. radius, this center of pressure would be ¼ in. inside the vertical axis at the base. The argument of many American railroad engineers that this side thrust is taken care of by frictional resistance is fallacious. In actual practice these vertical rails "spread" or "roll out." Under wheel load the horizontal thrust is continuously present; the rail tends to rise and fall slightly under impact, and it, therefore, tends to move or "spread" slightly upon each application of load. With a vertical rail—as in Fig. 1—the tendency is to wear the rail head parallel to the inclination of the wheel-coning, in addition to the wear on the inside of head due to grinding by the wheel flange.

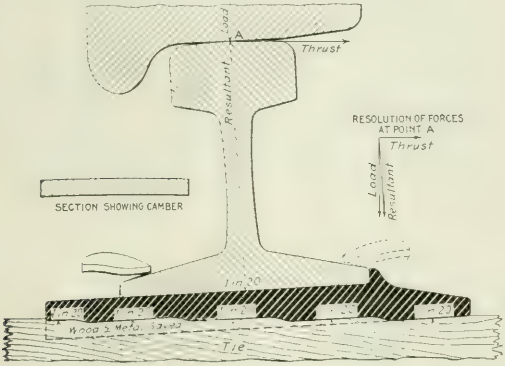

Fig. 2—Action of Coned Wheel on Inclined Rail.

When this inevitable condition of wear appears, a movement outward of the center of pressure on the base develops, with a consequent tendency to rail overturning, the side thrust, of course, still being present. Actual conditions of wear on vertical rails show that the average inclination of the heads of worn rails is greater than the angle of wheel-coning, thus proving that the rails have "rolled out." To incline the axis of the rail is the natural corollary of wheel-coning, without which feature of car-construction, the safe operation of railroads would be well nigh impossible.

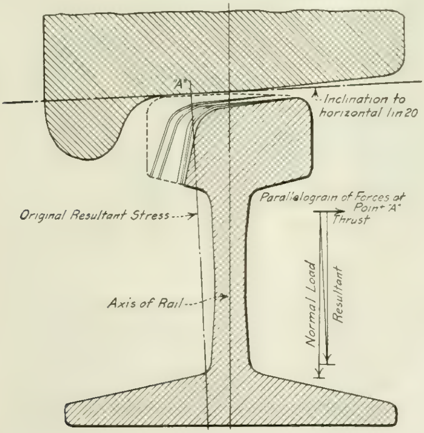
A
Inclination to horizontal 1 in 20
Parallelogram of Forces at Point "A"
Thrust
Original Resultant Stress
Normal Load
Resultant
Axis of Rail

Fig. 3—Results of Rail Wear After One Year's Service.

In Fig. 2 the action of a coned wheel on an inclined rail is shown. The center of bearing is in the center of the rail head, the resultant stress due to load and coning thrust, is axially through the web of the rail, and the center of pressure of this resultant is in the center of the base and at right angles to it, consequently there can be no lateral thrust at the rail base tending to move it outward on its seat.

These characteristics of an inclined rail, therefore, show that it acts as a normally loaded beam; and the rail wear will be such as to preserve substantially the surface of the rail head at right angles to the axis of the web. It is probable that the indeterminate internal stresses set up in a vertical rail under load, and which frequently cause splintering of the rail head, are due to its eccentric loading.

Practice has shown that for standard gage track a wheel-coning of 1 in 20 gives the most satisfactory results, although some roads still adhere to a ratio of 1 in 10. In comparatively recent times the British standard wheel-coning of 1 in 15 was reduced to 1 in 20. Any suggestion to reduce the wheel-coning to something flatter than 1 in 20 would appear to indicate ignorance of the underlying principles. Coning is also of use on curves by reason of the larger diameter of the wheel running on the outer rail and the smaller diameter on the inner rail; thus an adjustment is effected to suit the different radii of the outer and inner rails.

As a means of reducing the rail wear on curves, as shown in Fig. 1, a widening of gage thereon is essential. In cases where the gage on curves is not widened by intention, the traffic automatically produces a gage-widening with a consequent detriment to both wheel-flange and rail. By a combination of rail-inclination and gage-widening on curves the aforementioned wear is greatly reduced. Fig 3 shows results of rail wear after one year of heavy service, where the rail was inclined and the gage widened.

The sharp ridges shown on the bottom of the usual tie-plate undoubtedly defeat the designer's purpose, as under traffic these ridges bite into the wood, and then by continuous rocking of the plate the tie is so injured that proper bearing is destroyed. It would appear that a properly-ridged or stepped tie-plate base would remove this undesirable condition; and by giving the tie-plate, on the top surface in contact with the rail base, a slight circular camber parallel to the longitudinal axis of the rail, the bearing of the rail, deflecting as it does under load, will be uniformly distributed over the surface of the plate, thus preventing the usual tilting of the plate by reason of the greater intensity of load at the edges, and doing away with the rocking of ties and the clattering of plates.

The ideal tie-plate should provide for the proper inclination of the rail. The writer would like to suggest that by adopting a tie-plate designed with the above-mentioned features in mind, and with a proper inclination of rail to be used with the standard ratio of wheel-coning and adequate widening of gage of curves, a great gain in economy of track maintenance and smoother running would be secured, with the consequent reduction of rolling stock maintenance.

The French Government has appointed a committee of 15 members, to be known as the "Commission Consultative des Marches et des Stocks," the duty of which will be to study administrative and technical questions in reference to contracts for purchasing stocks of provisional houses and materials for provisional and final reconstruction work in invaded districts of France.

Graphical Determination of the Maximum Moments Produced in a Turntable

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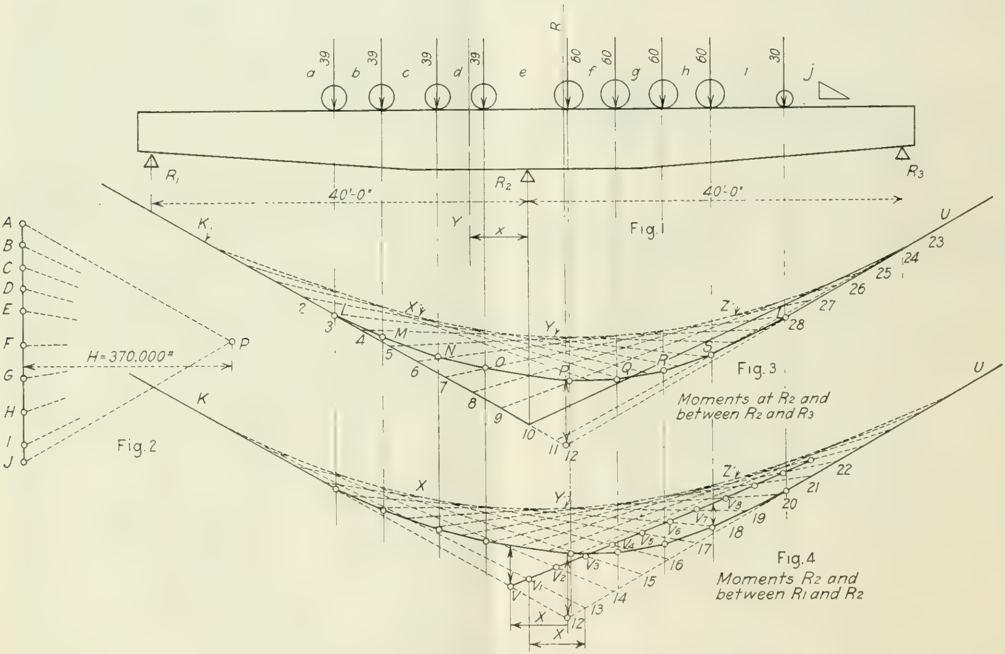
Figure 1 shows the outline of an 80-ft. turntable, across which an engine of E 60 loading is assumed to move. The engine loads are laid off in the force polygon, Fig. 2, and a pole distance H is chosen, thus locating the pole p. The funicular polygon K, L, M, ... U in Fig. 3 is now drawn and the first and last strings are extended back, their intersection locating the action line of the resultant of the engine loads.



Graphical Determination of Maximum Moments Produced in a Turntable.

When the loads have the position on the beam shown in Fig. 1, R_2 is directly over point 10, Fig. 3, and the moment diagram is L, M, N, ... T, 24, 10, L. In this case R_2 and R_3 are the two supports, while the left end is an overhanging end.

Now assume that the turntable is moved to the left, with respect to the loads, until the point 9 in Fig 3 is right below R_2; then L, M, N, ... T, 25, 9, L is the moment diagram. Now move the turntable to different positions with respect to the loads, keeping the resultant to the right of R_0 and obtain various other moment diagrams. Then draw the curve X Y Z tangent to the various closing strings 26-8, 27-7, 28-6, etc. Now the maximum vertical intercept between the curve X Y Z and the funicular polygon K, L, M, ... U, measured to the scale at which the turntable was drawn, and multiplied by the pole distance H from Fig. 2, will give the maximum positive moment that can be produced between R_2 and R_3. The maximum vertical intercept between the funicular polygon and the straight lines U-12 and K-12 times the pole distance H gives the maximum negative moment which can be produced at the center support.

Figure 4 is similar to Fig. 3 except that it has been drawn for the case when the resultant of all the loads is to the left of R_2. The maximum vertical intercept between the funicular polygon and the curve X Y Z times H gives the maximum positive moment which can be produced between R_1 and R_2.

Now let it be required to find the maximum moment which can be produced at any section YY, X distance to the left of R_2. Locate V, V_1, V_2, etc., on the various closing strings so that the horizontal projections of the lines V-12, V_1-13, V_2-14, etc., will all be equal to X. Then the maximum vertical intercept from the funicular polygon up to the curve V_8, V_7, V_6, etc., times H gives the maximum positive moment which can be produced at section YY. Also the maximum vertical intercept from the funicular polygon down to the curve V, V_1, etc., times H gives the maximum negative moment which can be produced at section YY.

This method is a development of the method for simple beams given on page 286 in Malcolm's Graphic Statics.

Plans for hospitals for all the 16 cantonments for the new national army have been completed by the office of the surgeon general and the work will be commenced by the cantonment division of the quartermaster's department and rushed to completion before troops are called under the selective service law.

Efficiency of Basic Pigments as Metal Primers

Tests to determine the efficiency of basic pigments as primers for metals have been made at the Institute of Industrial Research, Washington, D. C. The tests were placed in service during April, 1914. The results deduced from the three years' exposure are described by Mr. H. A. Gardner of the Insttiute in a paper presented at the recent annual meeting of the American Society on Testing Materials, from which the matter following is taken.

One object of the tests was to ascertain whether red lead of high or low basicity is best suited for protecting metal from corrosion. Other pigments which are known to be good metal protectives were included in the tests, in order to have a definite standard upon which to base the service of the red leads.

The paints were all applied to the same grade of black iron plates, 24 by 36 in., free from rust. The first coat of each paint was applied to the entire surface of the plate at a spreading rate of 600 sq. ft. per gallon. The plate was divided by a diagonal line from the upper right-hand to the lower left-hand corner, and the second coat was applied only to the lower right-hand half of the plate, at a spreading rate of 900 sq. ft. per gallon. Four days were allowed for drying between coats. The paints were all applied to the panels after they had been attached to the supporting fence frame. The red-lead paints were prepared so that they would all be practically of the same viscosity or body. A standard formula of 25 lb. of dry pigment to 1 gal. of oil was found practical except with the pigments on panel No. 6, which required more oil to bring it to working consistency and to relatively the same viscosity as the others.

The compositions of the paints applied are given in Table. I.

In previous tests Mr. Gardner observed that red lead which has been highly oxidized during production, and which is therefore practically a neutral pigment, is not as well suited for application to metal as red lead which is highly basic in nature and which contains a considerable percentage of litharge, the latter being a highly basic pigment. In the present tests the results obtained have been similar and have demonstrated the superior value of the incompletely oxidized or highly basic red leads. This was shown by an inspection of the paints at the end of 3 years' exposure, the results of which are recorded in Table II.

As a further result of the tests, it is quite apparent that two coats of the neutral iron-oxide paint (chromated or containing zinc chromate or zinc oxide) are superior to two coats of the neutral red-lead paint. The tests also demonstrate the excellent results to be obtained with one coat of a highly basic red lead. One of the most marked results from the tests was the comparative durability of one and two-coat work on an iron oxide-zinc oxide paint. This result would indicate that all metal should preferably be given at least two coats of paint when erected.

Much has been said regarding the hardening of red lead in packages, especially if the red lead should contain any pronounced percentage of litharge. It is interesting to record the condition of the paints used in these tests after standing for three years in half-gallon cans. When the cans were opened, some of the clear oil was removed from each package and ashed to determine the amount of pigment that had gone into solution. The results of the tests indicate that red leads high in lead tetroxide are quite as soluble in linseed oil as red leads high in lead monoxide.

TABLE I.—COMPOSITIONS OF PAINTS USED.

Panel No.	Pigment.	Grade: Lead tetroxide content, per cent.	Pigment in paint, per cent.	Linseed oil in paint, per cent.	Weight per gallon, lb.
1	Red lead	86*	80	20	27
2	Red lead	88*	80	20	25
3	Red lead	90*	79	21	28
4	Red lead	93*	78	22	24
5	Red lead	95*	80	20	27
6	Red lead	99*	72	28	21
7	Red lead	98†	80	20	24
8	Sublimed blue lead	Contains 1 per cent added carbon black	63	37	16.5
9	Chromated red lead	Contains 2 per cent CrO_3	76	24	22
10	Chromated iron oxide	Contains 1 per cent CrO_3	56	44	14
11	Iron oxide	Contains 10 per cent zinc chromate	55	45	14.5
12	Iron oxide	Contains 20 per cent zinc oxide	58	42	15

*Balance is litharge. †Special red lead purchased in paste form.

TABLE II.—RATING OF PAINTS AT INSPECTION APRIL 1, 1917, AFTER 3 YEARS' EXPOSURE.

10 = Excellent; 1 = Failed.

Panel No.	Pigment.	Grade: Lead tetroxide content, per cent.	One-coat work.	Two-coat work.
1	Red lead	86*	7	10
2	Red lead	88*	8	10
3	Red lead	90*	8	9
4	Red lead	93*	7	8
5	Red lead	95*	6	7
6	Red lead	99*	2	5
7	Red lead	98†	4	6
8‡	Sublimed blue lead		..	..
9	Chromated red lead	Contains 2 per cent CrO_3	8	10
10	Chromated iron oxide	Contains 1 per cent CrO_3	2	10
11	Iron oxide	Contains 10 per cent zinc chromate	2	9
12	Iron oxide	Contains 20 per cent zinc oxide	1	9

*Balance is litharge. †Special red lead purchased in paste form. ‡Panel injured when exposed. Removed from test.

TABLE III.—EXAMINATION OF PAINTS USED IN TESTS AFTER STORAGE FOR 3 YEARS.

Panel No.	Pigment.	Grade: Lead tetroxide content, per cent.	Condition.	Pigment dissolved in oil as shown by ash, per cent.
1	Red lead	86*	Stiff	2.55
2	Red lead	88*	Stiff	1.22
3	Red lead	90*	Fairly stiff	5.24
4	Red lead	93*	Stiff	15.82
5	Red lead	95*	Stiff	1.49
6	Red lead	99*	Fairly soft	0.31
7	Red lead	98†	Stiff	3.90
8	Sublimed blue lead	Contains 1 per cent added carbon black	Very soft	1.61
9	Chromated red lead	Contains 2 per cent CrO_3	Soft	0.80
10	Chromated iron oxide	Contains 1 per cent CrO_3	Very soft	0.50
11	Iron oxide	Contains 10 per cent zinc chromate	Very soft	1.48
12	Iron oxide	Contains 20 per cent zinc oxide	Very soft	1.22

*Balance is litharge. †Special red lead purchased in paste form.

The condition of the paints observed at the time of opening is also recorded in Table III, which would seem to indicate that the softness of red-lead paints after aging is due not entirely to the amount of litharge contained therein, but also to the settling properties of the red lead. In other words, red leads of high weight per volume will settle down to the bottom of the cans and become hard, whereas red leads of low specific gravity are more likely to be maintained in a bulky form.

The results obtained in the storage tests indicate that some chemical action takes place other than that to be accounted for by the formation of lead linoleate, since the latter is soft rather than hard. The writer is of the opinion that the chemical reactions which are partly responsible for the hardening of red-lead paints, cause the formation of lead glycerinate, a substance that is recognized as one of the hardest and most durable cementing materials. It is obvious, therefore, that linseed oil having a high acid number and often containing a substantial amount of free glycerin, is dangerous to use in making red-lead paints that are to remain in packages for a long period previous to use.

With linseed oil it is probable that a substance having a solvent effect upon lead glycerinate, such, for instance, as certain alcoholic derivatives, could be combined. These would evaporate when the paint was applied and the formation of the valuable lead glycerinate cement might proceed during the drying of the oil. For this purpose, red leads high in litharge would be most active.

Safe Loads for Ropes and Chains

The following tabulation showing the safe loads for ropes and chains is taken from a bulletin issued recently by the National Safety Council. The figures are based on a table prepared by the National Founders' Association. The safe loads are for each single rope or chain. When used double or in other multiples the loads may be increased proportionately. When handling molten metal, wire ropes and chains should be 25 per cent stronger than indicated in this table.

	Dia. In.		When used straight. Lbs.	When used at 60° angle. Lbs.	When used at 45° angle. Lbs.	When used at 30° angle. Lbs.
Plow Steel Wire Rope. (6 strands of 19 or 37 wires.) If crucible steel rope is used reduce loads one-fifth.	3/8		1,500	1,275	1,050	750
	1/2		2,400	2,050	1,700	1,200
	5/8		4,000	3,400	2,800	2,000
	3/4		6,000	5,100	4,200	3,000
	7/8		8,000	6,800	5,600	4,000
	1		10,000	8,500	7,000	5,000
	1 1/8		13,000	11,000	9,000	6,500
	1 1/4		16,000	13,500	11,000	8,000
	1 3/8		19,000	16,000	13,000	9,500
	1 1/2		22,000	19,000	16,050	11,000
	Dia of Iron, In.					
Crane Chain. (Best grade of wrought iron, hand-made, tested, short link chain.) The material having an ultimate strength = 48000#.□"	1/4		300	.....	.....	.....
	3/8		675	.....	.....	.....
	1/2		1,200	.....	.....	.....
	5/8		1,870	.....	.....	.....
	3/4		2,700	.....	.....	.....
	7/8		3,680	.....	.....	.....
	1		4,800	.....	.....	.....
	1 1/8		6,050	.....	.....	.....
	1 1/4		7,500	.....	.....	.....
	1 3/8		9,100	.....	.....	.....
	Dia. In.	Cir. In.				
Manila Rope. (Best Long Fibre Grade.)	3/8	1	120	100	85	60
	1/2	1 1/2	250	210	175	125
	5/8	2	360	300	250	180
	3/4	2 1/4	520	440	360	260
	7/8	2 3/4	620	520	420	300
	1	3	750	625	525	375
	1 1/8	3 1/2	1,000	850	700	500
	1 1/4	3 3/4	1,200	1,025	850	600
	1 1/2	4 1/2	1,600	1,350	1,100	800
	1 3/4	5 1/2	2,100	1,800	1,500	1,050
	2	6	2,800	2,400	2,000	1,400
	2 1/2	7 1/2	4,000	3,400	2,800	2,000
	3	9	6,000	5,100	4,200	3,000

The Building Contractor and Sub-Contracts*

It would be ideal if all sub-contracts could be handled by the contractor, just as the Government handles their lettings; simply awarding the contract to the lowest bidder who properly qualifies.

In many such instances the Government loses by the transaction; not always in actual dollars and cents paid out for actual construction, but in many indirect ways that will occur to all of you; many months' delay in the completion of the building resulting in expense for additional rent, and for salary of Government Superintendent, much more labor and trouble in the office of the Department, unsatisfactory results that have to be accepted in the end.

Why is it that the contractor cannot strictly apply this same method in placing his sub-contracts? Because, if he expects to make his contract a profitable one, or at any rate expects to prevent loss on his contract, his work must go along systematically, his material must be delivered at the proper time, and the work must be accomplished at the proper stage; all the bond in the world will never enable the contractor to progress with his brick work, for instance, if the brick have not been delivered; and if there is such a delay, the direct and indirect expense to the contractor is incalculable.

It is human nature to place a sub-contract with the lowest bidder, and thereby save apparently a goodly sum of money, but how often have we each found that this course sometimes results in a loss of more than we expected to gain. It is such risks as these that justify the contractor in undertaking so far as practicable, to develop mechanics in all the various branches of work, placing in the hands of his foreman the responsibility for the expeditious, economical and satisfactory execution of the work.

Primarily the argument for a general contractor would be based upon his ability to get branches of his work executed properly, economically and satisfactorily; why should a contractor who places the responsibility on his foreman for employing bricklayers and getting brick laid, and carpenters to install the wood work, find it necessary to make a sub-contract to have the painting done and to what extent and when is a contractor justified in carrying this plan into further branches of his work?

What does he gain by sub-letting such work? The certainty of what it is going to cost, the freedom from detail, the assurance of getting skilled men; all these are good arguments, but what will such a course cost him? and in how many instances is he assured that in the final windup he will have secured any or all of these benefits?

Where a contractor goes into territory that is foreign to him he feels that there is an advantage in placing this responsibility on others who will be more familiar with local conditions, but his lack of familiarity with local conditions carries with it also a lack of knowledge as to who to trust in placing such sub-contracts; and such a lack of knowledge may prove his undoing.

Under what circumstances can a general contractor ordinarily afford to place sub-contracts of this kind? One way would be by having developed sub-contractors who will go from place to place and who, by experience, he will have found able and willing to work as hard as he does and shoulder their responsibility and make good.

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*From a paper presented at the last annual meeting of the Association of Government Contractors by Algernon Blair, President of the Association.

In the selection of a manufacturer of material the contractor may go far wrong in selecting the lowest quotation; what is he to do? He can hardly afford to say: "I will never buy from a new man" because the supply of experienced manufacturers would thereby some day be exhausted if that rule were followed generally. It is suggested that he should decline to accept quotations radically below others received, or radically below his judgment of the reasonable amount; he should protect himself in every reasonable way, and he should make special effort to cooperate with the material man, that the probability of errors may be reduced as much as possible.

What has the manufacturer a right to expect from the contractor; full and complete data, prompt reply to all communications; explicit and plain information; careful handling of material at the building, prompt statement of damage to shipments, or the discovery of errors in work; very prompt and explicit statement of any charge that the contractor may make against him, these statements being supported by proper vouchers, freight bills, or otherwise, to show clearly why such charges are made. Full and prompt compliance with the terms of agreement as to payments. How often we hear the expression that the contractor does business on the money of the material man or sub-contractor.

What has the contractor a right to expect from the manufacturer, and from the sub-contractor? Prompt handling of all correspondence; prompt and complete furnishing of the required shop drawings, and samples; cheerful acquiesence in the reasonable demands of the superintendent appointed to interpret the specifications; a realization that he, the material man, has undertaken to comply in behalf of the contractor, with all the terms and conditions of the general contract so far as they relate to his particular part of it.

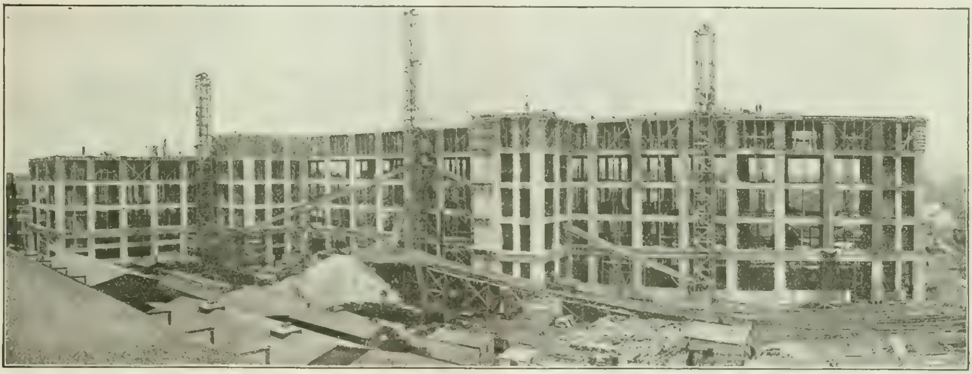
The contractor has a right to expect from the manufacturer prompt delivery of materials at the time and in the order in which they are needed.

It is entirely possible to arrive at an ideal condition in respect to the transactions between contractor and manufacturer, or sub-contractor. There is a legal maximum still quoted in the courts "Caveat emptor" —let the buyer beware—but surely it must not be a case of "Caveat emptor" between contractor and manufacturer or sub-contractor, but of honest, intelligent co-operation.

Construction Methods for Erection 6-Story Reinforced Concrete Building

Construction plant, having several interesting features, was used by the John W. Ferguson Co., New York City, in the erection of a 6-story reinforced concrete building for the Sprague Electric Works. The building will add over 300,000 sq. ft. of manufacturing space to the plant at Bloomfield, N. J.

The mixing plant is located on the southern side of the building about midway between the ends of the proposed structure. Three hoisting towers were erected, one at the mixer and the other two half way between the mixer and each end of the building. Concrete was mixed at the one central plant where adequate provision was made for receiving the cement and aggregates and also for storing sufficient quantities of both. The concrete was then hoisted up the central tower and dumped into one of three hoppers on this tower. Two of the hoppers feed line chutes running to the two remaining towers. The third hopper is for loading the concrete barrows that distribute the concrete for the columns and floors near this tower. When floors and columns are to be concreted at either end of the building the concrete is hoisted up this central tower, allowed to flow down one chute or the other and is then hoisted by bucket up the side towers to a receiving hopper, from which points it is distributed by concrete barrows.



Hoisting Towers and Material Handling Arrangement for Construction of Sprague Electric Works Building.

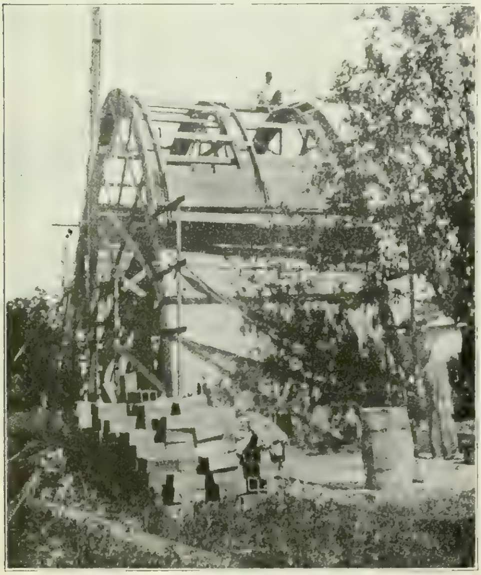
Cement is received by rail and sidetracked near the building site. From there it is run in on small industrial cars to the mixer and the storage sheds nearby. Had there been sufficient room a siding would have been laid of standard gage track alongside the building. Sand and stone are delivered to the site by Pierce Arrow trucks. These climb a fairly steep runway and deposit their loads over the tops of the storage bins, the bins being filled through suitable gratings. Surplus stone is also piled beside the regular storage bin, being dumped off the platform by the trucks. Here it is handled by a jib boom and bucket, and placed in the storage bin when that becomes empty. In one instance this extra storage outside of the bins has tided over a lapse in the delivery by the trucks.

Reinforcing steel, lumber, steel forms, etc., are delivered to the site by rail and brought in by the smaller industrial cars. For hoisting material to the various floors as the job progresses, auxiliary jib-booms, attached to the sides of the towers, are used.

Masonry Arch Roof for Barns

An unusual design of roof for barns is being tried out at the Iowa Agricultural Experiment Station at Ames, Ia. The roof is arch shape and built of reinforced concrete and hollow tile. An experimental section of arch suitable for the average barn was erected during the summer of 1915 by the agricultural engineering section of the station. The experiment was described by Mr. W. G. Kaiser in a paper presented at the last annual meeting of the American Society of Agricultural Engineers, from which the following notes are taken.

The equation of an inverted catenary was used in the preliminary design. The arch was made 36 ft. wide and 24 ft. 7 in. high to the crown. Reinforced concrete ribs were designed to carry a wind load of 30 lb. per square foot according to the elastic arch theory. Hollow tile was used as sheeting between the concrete ribs, tile being chosen because it is a lighter material than concrete and less form work was necessary.



Showing Formwork for Masonry Arch.

The forms for the arch ribs were quite complicated. Each one was built so that it could be easily taken down and re-erected. Over $100 was expended in buying the lumber to make the forms for this arch. However, once constructed, they can be used many times. The forms had to be well braced in order to withstand the heavy loads without deflection. Up until the time that the arch is closed the entire weight of the arch must be sustained by the form work.

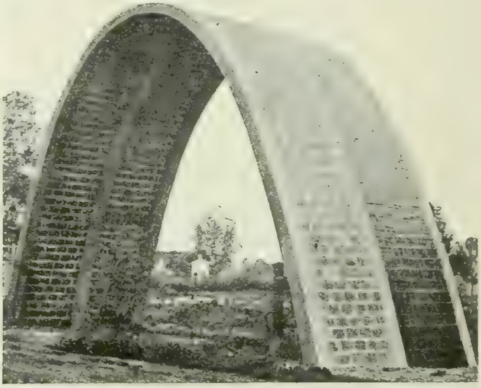
Each rib was reinforced with eight ½-in. square twisted bars, four on the top and four on the bottom. No. 6 wire was carried across the arch in every mortar joint between the tile.

The tile were laid up in sections trying to keep both sides of the arch about the same height in order that the loading on the forms would be better distributed. The concrete in the ribs was poured after the sections of blocks were laid. The concrete was allowed to run back into the air space in the tile, thus securely bonding the rib to the hollow tile sheeting. After the arch was completed it was washed with diluted HCl to remove the mortar stains.

The completed arch was not water tight and with the first shower water poured through the mortar joints between the clay blocks. This brought up the problem of securing some waterproof coating. Three methods of waterproofing are now being tested: (1) An application of a cement wash. (2) A coating of bituminous roof paint. (3) A commercial integral waterproofing compound.

Up to the present time each of these have been quite satisfactory. Dampness, however, can sometimes be detected on the under side after a heavy rain.

As yet no tests have been made on this arch except a weather test. At the present time there are no signs of cracks, defects or failure of any sort.



Complete Masonry Arch for Barn Roof.

Some facts and figures about this arch are:

Span of arch, 36 ft.
Height to crown, 24 ft. 7 in.
Length of section, 12 ft. 10 in.
Distance between ribs, 6 ft.
Perimeter of arch, 65 ft.
Depth of rib, 8 in. at crown increasing to 11 in. at springing line.
Width of rib, 10 in. throughout.
1,400 lb. steel reinforcing.
900 hollow tile, 5x8x12.
More than 200 cu. ft. of concrete.

In using this arch as a barn roof it is planned to have the arch begin at the loft floor line. This type of construction presupposes masonry walls and a reinforced masonry loft floor. Another plan is to have the arch extend to the foundation as the bottom 8 ft. of such an arch would be quite perpendicular and could be used as the barn wall.

The city of Pernambuco, Brazil, is installing a new system of street numbering. The metric system is used. If for instance the number of a house is 134, then that particular house is 134 meters from a certain starting point. The house across the street would be 135 meters or the nearest number to the actual distance from the starting point. The system is being used in several cities in southern Brazil, having been first tried in the city of Bello Horizonte.

City Managers: A New Opportunity for Engineers

The opportunities in the city management field are pointed out by Mr. Gaylord C. Cummins, City Manager of Grand Rapids, Mich., in an article in The Cornell Civil Engineer. In his article, which is reprinted below, Mr. Cummins points out the possibilities in the field and makes suggestions as to how the engineer should take advantage of them.

The great field of public service has had but little attraction in the past for engineers who were ambitious and far-seeing. The opportunities were generally purely local, and promotion was dependent more on political standing than upon efficiency and professional ability. In fact until within the last decade an engineer could not look forward to anything but a slow advance at meager salaries as a subordinate in a city engineer's office, or if City Engineer, no matter what his record might be, of being displaced by a shift in local politics. Within the last decade an efficient City Engineer has had a chance to be drafted by some larger city on the basis of his record, and the same has been true of water works superintendents, etc.

Even at the best, however, there was not a sufficient incentive for a young, ambitious engineer to look forward to a life in the service of the public. The engineer has always occupied the position of an underling in city affairs. He seemed content to keep clear of the larger aspects of public affairs, and take what came his way with thankfulness. It is only within the last few years that he has started to take his true place in private business, and now he is taking his true place in public business, and public service at last can promise enough so that the highest type of engineering ability can be attracted with an incentive of opportunity such as exists in no other field where the engineer is pre-eminent.

This condition has been brought about by the advance of the so-called Commission Manager form of municipal government. This plan has been given much publicity in the last few years, and no space will be taken here in going into an extended explanation as to its whys and wherefors.

In brief, the Commission Manager Plan is the best effort so far made to get responsible government. It is an application of the form of organization proven to be the best in private corporate business, to public corporate business. Its advocates argue that the same principles apply in all essentials to these two classes. A private corporation exists for the purpose of paying cash dividends to its stockholders, a City Government for the purpose of paying dividends of service to its people. The measure of efficiency of each is the percentage which is furnished for the expenditures involved. Thus the administrative side of a city is simply a business proposition and should be treated as such. Our many and various troubles in this field are due to a lack of recognition of this important principle.

The Commission Manager Plan consists of a small legislative body elected by and responsible to the people. This body is the policy forming body of the city, and appoints a chief administrative officer, the City Manager, who is responsible to it, and has complete power to administer and carry out the policies laid down by the legislative branch. The legislative body or commission corresponds to a board of directors of a corporation, the City Manager to the general manager. This form of organization does not insure efficient or honest government, nor will any other form do so, but applying our common experience in business affairs, it is the only form under which efficiency can be secured, and honesty is much better conserved by centralized responsibility than any system of "checks and balances" that can be devised.

Suffice to say that this plan is doing just the things claimed for it in over 80 towns and cities in this country and the number is growing by leaps and bounds.

The chief thing of interest to readers of this paper is that a large proportion of the present City Managers are engineers. All of the larger cities with the exception of San Jose, Cal., have engineers as City Managers and many smaller ones find it absolutely necessary to have engineers.

The engineering profession seems to be the preferred field from which to take City Managers, and this is not at all surprising when it is appreciated that fully 75 per cent of municipal problems are engineering problems, speaking of engineering in its broader sense.

A City Manager must be primarily an executive, his previous training and experience are worth nothing without that qualification. Unquestionably an engineer is very much better fitted for such a position than a man with any other training. A non-technical man can cope with the problems of organization, finance and social service, but he cannot work into the technical questions which form so large a part of his work, and must take someone's word for everything in that line. An engineer, and again I speak of engineering in its broad sense, has a grasp of the technical questions involved, must have a good idea of organization if his experience has been at all broad, and must have a knowledge of the general principles of finance and accounting if he has been in responsible charge of work. The only field in which he is entirely new is that of social service, and the fact is indisputable that greater advances have been made along social lines in cities managed by engineers within a few years than had been made in them during the preceding twenty. Certainly, other things being equal, the man with a technical training is to be preferred as City Manager.

The openings in this field for the younger man are in the smaller cities and towns. A large number of towns from 3,000 up are taking up the City Manager plan, and a man who handles the problems of such a place successfully can look forward to rapid promotion to larger towns, as there is a lack of men of experience in this line, and a man who has been under the load and gotten results is sure of abundant opportunity to advance. To inject a personal note, the writer of this paper has had during his two-year service in Jackson, Mich., six offers at increased salary, the last of which he took when called to Grand Rapids, this coming after conditions in Jackson were such that he could feel justified in turning the work over to another man.

The young man who wishes to get into this field must take a broad view of engineering, he must keep in touch with many things outside the strictly technical field, he should if possible get into municipal work as a subordinate for a time, find out whether or not he can handle men, and broaden his knowledge in every possible way along the lines of municipal government.

Then when an opening as City Manager for a small town presents itself he will be in a position to apply, and remember, apply in person, and thus get his start in the field.

This is the most promising field for engineers at the present time and has unlimited possibilities. A young man cannot do better than take up as a life work the profession of public administration. It entails many sacrifices because your time is never your own; it means unjust and unfair criticism, but the public is learning to appreciate honest and efficient service, and the pleasure of untangling some awful mess in local misgovernment, and making it into an efficient machine for rendering service, is worth every sacrifice made.

Water Proofing Concrete Dam with Cement Gun

The Nevada-California Power Co. has recently completed the waterproofing with a cement gun of the base of its concrete dam at Agnew Lake in Mono County, California. The gun was mounted on a barge which was floated up against the face of the dam and the water being lowered or raised as required to reach the structure at the different elevations. About 70 or 80 lb. of air was used in the gun. The mixture was 1 part cement to 2 parts of sand. The sand was redried before placing in the mixing chamber and one man watched the mixture while the other man managed the nozzle and shot the gunite on the face of the structure.

Barge and General Equipment Used in Gunning Agnew Lake Dam.

The face of the concrete was first thoroughly wet by squirting water on it with the hose and then the mixture of aggregate and water was regulated by the gun handler to suit the conditions.

The gunite was placed upon the dam in thicknesses varying from ¼ in. at the top to 1¼ at the bottom, depending entirely upon the pressure that the gunite is placed under. The company has found this method of waterproofing its dams very satisfactory, having scarcely any leaks with the full pressure of 80 ft. upon some of its work. It has had samples of the gunite placed under test and a piece of it 1 in. thick failed to show any leak under a 1,700-ft. pressure. The piece finally broke under 3,400-ft. head.

The work was done under the direction of C. O. Poole, Chief Engineer, The Nevada-California Power Company.

The Transportation Division of the War Department has awarded contracts for the supply of 10,550 motor trucks.

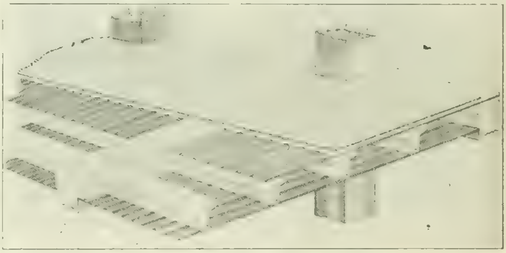
New Method of Combining Metal Lath and Concrete

A new and simple method of combining metal lath and concrete in reinforced concrete building construction is being employed in the erection of the 12-story building at 15th and K streets, Washington, D. C., for the Federal Trade Commission.

The unit around which the work revolves is a special shaped steel form by which a concrete T-beam is rapidly formed in conjunction with the tying in of the reinforcing rods, a metal lath floor reinforcement, and the metal lath for the ceiling plaster.

After the first wood framework is set up as in the majority of reinforced concrete construction, the entire area of the building is laid with metal lath on top of the wood framework. Reinforcing rods are then set up and accurately spaced for T-beams on centers of 28-in., and the metal special shaped forms are set in place on top of the lath and wood structure. These forms are spaced with wood wedges cut to accurately space out the forms and they are left in place until after the concrete T-beams have received their initial set, when the wedges are taken out and the metal forms removed.

These forms are removed upward instead of downward and can, therefore, be removed before the beams are strong enough to support their own weight, thus greatly speeding up the process of erection. In fact, the new Federal Trade Commission Building has gone forward at the rate of one floor poured every five working days.



Section of Floor Showing Method of Using Metal Lath.

After the metal forms are removed, the electric wiring, plumbing and gas fitting contractors get right on the job and complete their work on the particular floor under construction and another expanded metal lath web is run over the entire area of the building. On this web is poured a 3-in. cinder concrete floor, the metal lath serving for both reinforcing and base to hold the concrete.

After the roof beams were in place, metal lath was webbed over them and the roof was poured of concrete, wires to support the metal lath suspended ceiling having already been keyed into the roof supporting beams.

It is stated that estimates made on this particular job indicate that the saving in steel due to this method of using metal lath will vary from 20 to 30 per cent over normal for a building of this type and size.

The T-Beam Engineering Co., Washington, D. C., is the contractor for the Federal Trade Commission Building, and B. Stanley Simmons, Washington, D. C., is the architect.

Constructing 590 x 240 ft. Concrete Building at Rate of One Floor Per Week

A concrete plant particularly well designed for fast, steady mixing and placing and which has several unusual features of interest, is being employed by E. W. Sproul Company in building a 6-story and basement 590x240 ft. storage warehouse for Montgomery, Ward & Co. at 39th and Robey Sts., Chicago.

The mixing plant, consisting of two ¾-yd. Milwaukee mixers, stone, sand and cement storage bins, is located at the exact center of the building. See Fig. 3. Sand and stone cars come in on a trestle level with the first floor and extending from the west side of the building to within 40 ft. of the mixing plant, and dump through the trestle into a long hopper bottom storage bin. On each side of the V-shaped bottom of the bin is a conveyor belt leading to the storage bins above the mixer, one for sand and the other for stone. These bins are placed one over the other, a unique arrangement which gives the maximum amount of storage for a minimum area of space.

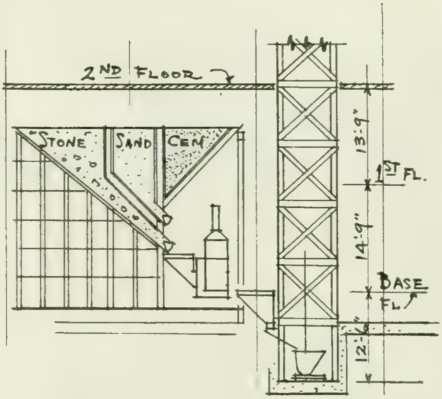


Fig. 2.—Arrangement of Hoppers, Mixer and Tower.

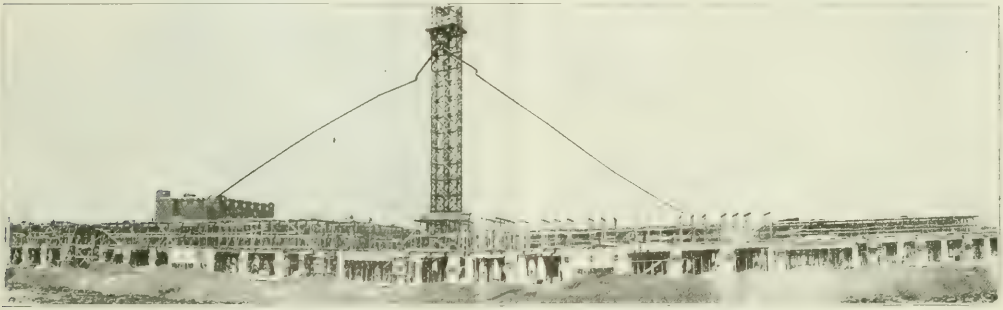


Fig. 1.—Construction View of New Storage Warehouse Being Erected for Montgomery Ward & Co

Bags of cement are delivered to a shed on the first floor and two men wheeling and two men emptying sacks keep a steady stream of bulk cement dropping through a floor hopper onto a conveyor belt which in turn delivers to the cement storage bin. The cross section view (Fig. 2) shows the arrangement of the storage bins.

The two mixers empty into a common hopper of

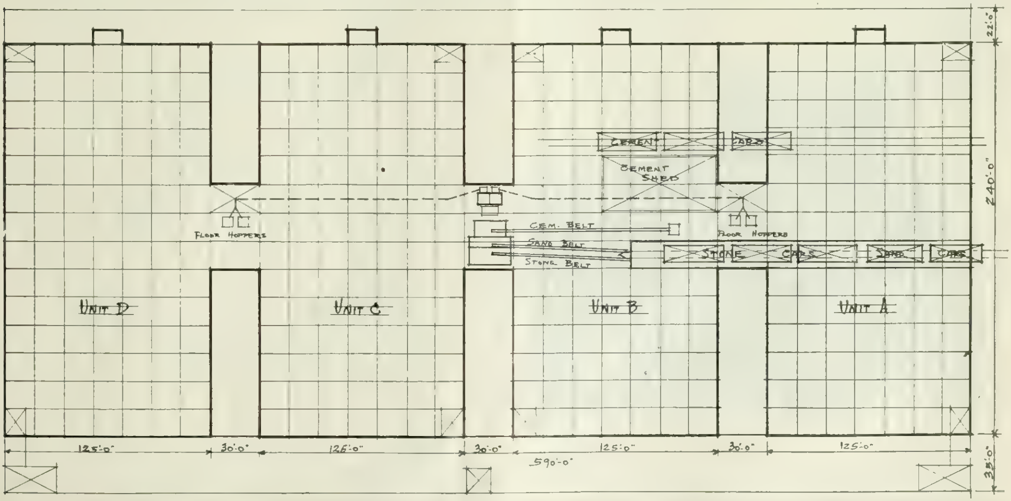


Fig. 3.—Concrete Plant Layout for Storage Warehouse for Montgomery Ward & Co. at Thirty-ninth and Robey Streets., Chicago.

about 3-yd. capacity which by means of a hopper bottom with two-way spout feeds two 1-yd. Lakewood hoist buckets operating independently in a double can be filled simultaneously or one bucket can be filled while the other is traveling up or down, or either mixer can be operated separately with either hoist tower. Thus, each bucket is always hoisting more than a full batch of the mixer and both buckets bucket. At the top of the tower the buckets dump into separate hoppers emptying into a three-way chute from which the two lines of spouting diverge. This permits of spouting all the concrete one way or one tower can serve the spouts in both directions if necessary.

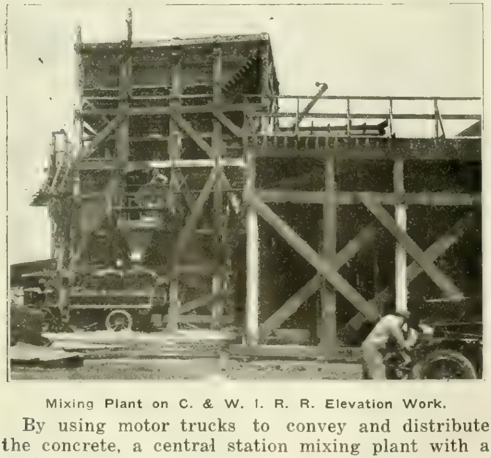
The two lines of spouting extend east and west from the twin-towers 125 ft. in each direction and each line dumps into two floor hoppers placed back to back. This divides the floor into four equal units and the distance from any point in one unit to the floor hopper situated in that unit is the same as from a corresponding point in another unit to its floor hopper. This makes it possible to keep the wheelers moving with almost clock-like precision.

This plant was designed to mix and place 900 cu. yd. in eight hours, but it has turned out over 1,000 cu. yd. on some days. The last three floors have been poured at the rate of a floor a week; the fourth floor was started June 29; fifth floor, July 5; sixth floor, July 12, and the roof, July 20. The last of the 40,000 cu. yd. of concrete will probably be in place before Aug. 1.

Motor Trucks Deliver Concrete for Track Elevation Work

Motor trucks are the concrete carriers used by W. J. Newman Co., Chicago contractor, in building retaining walls for track elevation and yard extension of the C. & W. I. R. R. in Chicago.

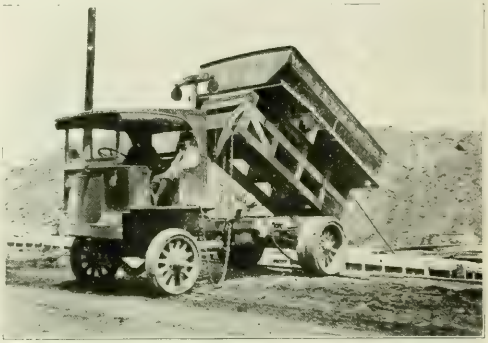
The job involves the placing of concrete at scattered points over an area approximately 3,500x400 ft. The retaining walls will extend along Canal St. for a distance of six city blocks north and south from 23d St. to 29th St. with abutments at each intersecting street extending east to the present track elevation of the C. & W. I. R. R. and Pennsylvania Lines, a distance of about 400 ft.



Mixing Plant on C. & W. I. R. R. Elevation Work.

By using motor trucks to convey and distribute the concrete, a central station mixing plant with a 1-yd. electric-driven Lakewood mixer is made to serve the entire job. The mixing plant is erected on the west side-hill approach of the 25th St. viaduct of the C. & W. I. R. R. and is built so that the mixer loading platform is at the track level with sand and stone storage bins above. Two sidings provide ample track room for material cars. A Lakewood clamshell bucket is operated 12 hours a day unloading sand and stone from cars to bins, starting two hours ahead of the mixing plant in the morning and continuing two hours after the mixer has shut down in the afternoon.

The footings poured up to date (July 21) are on 23d St., 23d Place, 24th St. and 24th Place, and Canal St. between these streets and involved the placing of concrete at distances varying from 500 to 1,200 ft. from the mixing plant. The method used was as follows: Three 6-ton Garford trucks, each carrying 3 cu. yds. of concrete, followed a route from the mixing plant to the forms and around a loop back to the plant. The concrete was dumped by the trucks onto a chute and into the forms, filling the forms to within 2 ft. of the ground level. Placing the concrete for the top 2 ft. of the footings was much more costly. For this part of the work the concrete was delivered in 1-yd. bottom dump buckets, each truck carrying two buckets. The concrete was poured by lifting the buckets out of the trucks and over the forms, a Thew steam shovel serving as a crane.



Truck with Built-up Frame.

On the remainder of the footings, the contractor expects to pour all the concrete directly from trucks into forms by using trucks with bodies raised 30 ins. above the chassis on a built-up framework. The illustration shows a truck, so constructed, backed up to a concrete-filled form and with dump body hoisted. A fan-shaped chute will be bolted onto the rear of the truck so that the concrete can be dumped into place by the truck driver and only one laborer will be required at the forms. An output of 300 yd. placed per day is expected, although the best 8-hr. record to date is 284 yd.

For the retaining walls proper, Blaw traveling wall forms will be used and the method of delivering concrete in bottom dump buckets will be followed with a Browning locomotive crane to lift the buckets out of the trucks and up to a chute which dumps into the forms.

The total yardage for the footings is about 17,000 cu. yds. and for the walls and abutments about 30,000 cu. yds.

Herbert Kent is contractor's superintendent, and H. L. Hodges engineer for the C. & W. I. R. R.

Road and Street Issue
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HALBERT P. GILLETTE, *President and Editor.* W. H. FOGERTY, *General Manager.*

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No Such Thing As "100% Economic Efficiency"

The late Judge Pennypacker of Pennsylvania, while hearing a rate case before the Public Utility Commission, interrupted an engineering witness who was testifying that, due to the progress of science, every utility plant constantly undergoes rebuilding.

"But, surely," said the commissioner, "you do not expect this condition of perpetual change to continue indefinitely. You are constantly aiming at perfection, I know, but you are therefore constantly coming nearer to your goal; and some day you will arrive. Thereafter this functional depreciation that you speak of will cease."

"No, you are wrong," replied the witness. "Although there is such a thing as 100 per cent mechanical efficiency, which, if not entirely attainable, may at least be approached very closely, there is no such thing as 100 per cent economic efficiency. It is a fallacy to assume that there is, for it will always remain possible to improve economically on the best that has ever been done."

The judge, who was an extremely well-read man, seemed unable to grasp the distinction between mechanical efficiency and economic efficiency, so he persisted in his questioning until he finally propounded this poser:

"Well, if economic perfection is never attained anywhere, will you explain why it is that the ax has remained unchanged for a hundred—and I don't know but five hundred—years?"

The engineer replied: "I am glad you selected that illustration, for I happen just to have read that axes have been greatly improved recently by the use of new steels containing small quantities of chromium, which serves to harden the steel to such an extent that an ax can be used for weeks without sharpening."

The engineer might have gone farther, pointing out that axes have been largely displaced by hand saws, and hand saws by power-driven saws in logging camps.

We wonder whether even engineers are always free from the misconception that exists frequently among non-scientific men as to the possibility of attaining an economic efficiency of 100 per cent. And we are led thus to wonder about engineers whenever we consider how many of them practically cease engineering and scientific reading a few years after graduation. Surely no man would stop such study unless he felt either that he had attained almost 100 per cent economic efficiency, or that it profits no one to advance more than slightly beyond his fellows.

The Maintenance Cost of Plain Concrete and Tarred Concrete Compared

At the annual meeting of the Virginia Road Builders' Association, W. F. Childs, resident engineer of the Maryland State Road Commission, gave some maintenance data based on experience with concrete roads in Maryland.

On the Salisbury-Ocean City Road, 17 miles long, built in 1914, one section was left without a bituminous top, and another section was covered with a mat of tar and stone chips 3/8 in. thick. The maintenance costs of the two sections have been approximately as follows per mile per year:

	Without tar mat.	With tar mat
Surfacing, including tar and chips	$24.00	$30.00
Miscellaneous materials and supplies	6.00	8.00
Earthwork	13.00	11.00
Total per year	$43.00	$49.00

For a (1:2:4) concrete pavement 14 ft. wide and averaging 6 in. thick the contract price was $1.30 per sq. yd., and the tar mat added 10 ct. per sq. yd., or $520 per mile.

Based on these maintenance costs, Mr. Childs believes that the surface of concrete road should be left bare until it has worn to such an extent as to become rough, say for five years under "normal traffic conditions." Then a bituminous top 1 to 2 in. thick should be placed on the roadway.

One Reason for Low Salaries for Teachers

If the mythical man from Mars, possessing a knowledge far transcending ours, were to visit this planet, it seems certain that he would be astonished at our entire system of compensation for services rendered. Learning that Charlie Chaplin receives a remuneration of a million dollars a year, he would exclaim:

"There is a genius whom I must meet at once, for he is advancing the welfare of humanity at a prodigious pace, else society would not reward him so lavishly."

But his earthly guide would try to dissuade the Martian, urging a visit first to some one of our scientific professors whose contributions to the world's useful knowledge has been great, or perhaps to some teacher who had trained such a genius as Langmuir or Pupin. The Martian may be conceived as then asking:

"How much greater salary does this professor receive than that awarded to Mr. Chaplin for his evidently enormous service to mankind?"

"About three-tenths of one per cent as much."

"Yet you mean to say that I should visit this evidently inconsequential professor first, this earner of a paltry $3,000 a year?"

"You should. I am sorry to tell you that on this planet we have no rule of award such as you apparently have on Mars. We leave the matter largely to the vote of the populace. The service that pleases the crowd most usually determines the size of the emolument. We dignify this practice by calling it the operation of the law of supply and demand."

"My word!"

The economic law that, to secure the greatest economic progress, men should be paid in proportion to their personal contribution to general efficiency, is self-evident. If it were permitted to operate freely, the salaries of our most effective teachers would equal the present incomes of our most talented comedians; and perhaps the incomes of our comedians, and our star baseball players, and our patent medicine manufacturers would volplane swiftly from their financial eminence.

Amid the mass of errors that socialism has embraced, there is a justifiable protest against the present system of human rewards. Their greatest error consists in aiming to equalize compensations under a system that would put an Edison almost on a parity with any of his subordinates in the matter of income.

The salaries of our teachers will remain inordinately small until scientific men have a prepondering voice in determining what they should be.

The Crying Need of More Data on the Life and Repair Costs of Roads and Pavements

Isn't it high time that highway engineers produce more statistics and fewer guesses as to the life of pavements under given conditions? We have repeatedly criticised estimates of the annual cost of pavements of different types, and have quite as frequently called for data to back up the estimates as to depreciation and repairs. Yet year after year goes by with no satisfactory addition to published knowledge on these important elements of road and street cost.

Recently an engineer of a state highway department published an article giving estimated annual costs of different types of roads. His estimates were as follows:

	9-ft. gravel.	16-ft. gravel.	16-ft. bit. surf. macadam.	16-ft. waterbound macadam.	16-ft. concrete.	16-ft. brick.
Cost per mile	$3,000	$4,000	$9,000	$8,000	$16,000	$22,000
Interest, 5 per cent	150	200	450	400	800	1,100
Depreciation fund	282	376	392	753	538	494
Maintenance	100	150	350	200	100	50
Total annual cost	$ 532	$ 726	$1,192	$1,353	$ 1,438	$ 1,644
Years before rebuilding	5	5	10	5	15	25
Limit of daily vehicles	200	500	1,000	500	2,000	2,400

The depreciation fund is assumed to earn 3 per cent interest and to be used for rebuilding the road at the end of the term of years given in the table.

In the case of gravel and waterbound macadam the road is assumed to be rebuilt (resurfaced) at the end of 5 years for one-half the original cost, and it is assumed that these types of roads are not economic for more than 500 vehicles daily. We should like to see the actual records to justify any such estimate of the cost of resurfacing roads of this type after having spent $100 to $200 a mile in annual maintenance. Such records as we have printed during the last decade certainly do not accord with the assumptions of this engineer.

The bituminous macadam is assumed to be resurfaced at the end of 10 years for 50 per cent of its original cost. The concrete road is assumed to be resurfaced with bituminous concrete or otherwise rebuilt at the end of 15 years at a cost of $10,000 a mile, or about 62 per cent of its original cost. The brick road is to be rebuilt at the end of 25 years at a cost of $18,000 a mile, or about 82 per cent of its original cost! We challenge every one of these assumptions, and demand the supporting data.

There is an unusually prolific production of articles in which guesses are made to serve for facts in estimates of this sort; and we fear that such articles indicate altogether too much guessing on the part of road designers. Most of us are capable of calculating the annual cost of a road if we possess reliable data as to life and maintenance under stated conditions. Let us have more data.

The Mayor of Atlanta Has a Board of Consulting Engineers

Acting upon a suggestion of an engineer, Mayor Candler of Atlanta, Ga., has appointed five engineers to serve as a consulting board. The board meets twice monthly and makes suggestions to the City Council. The members are: J. N. Hazlehurst, Cecil P. Poole, G. R. Soloman, H. F. Hontz and A. M. Schoen. They serve without compensation.

We commend this plan to the careful consideration of our readers in every city in America. It is a simple method of gaining for engineers a standing in the eyes of the community not readily attainable otherwise. Given the opportunity to shape the course of municipal legislation, it would be a weak body of engineers indeed that could not win for itself the esteem and gratitude of the public.

Handling Paving Brick in "Packets" and "Cages"

In his "Bricklaying System," Frank B. Gilbreth describes the use of wooden "packets" on which bricks are piled and thereafter handled in unit groups. This cheapens the cost of loading and unloading, for bricks are not handled individually, but in bunches. Moreover, since each bricklayer is required to keep the wooden "packets" on file, the number of brick laid by each man can be ascertained.

The Gilbreth "packet" is made of a few small pieces of lumber, forming a flat platform on which about a dozen bricks are piled. An evolution of this plan is to be seen in the "cage" that holds about 75 "pavers" weighing 500 lb. A "cage" is a flat platform with iron stirrups that pass under its bottom and project upward at each end to a height of 4 ft. Brick are stacked on this cage, and a portable derrick is used to handle the loaded "cage." The end of the derrick line has a "yoke" attached, and this "yoke" is slipped into the loops of the iron stirrups.

An auto-crane operated by one man can thus handle bricks from the car onto a motor truck, and another derrick can unload the "cages" at the road or street where the "cages" are dumped and the brick are stacked in piles.

A few years ago, when common laborers could be hired for half the present wages, the use of small derricks for handling "skips" full of materials was economic. Today the economy is far greater.

The Economy of Motor Tractors for Street Cleaning

Repeatedly we have urged the flushing of city streets, for we believe that not until flushing is generally adopted will there come a marked reduction in respiratory diseases. While flushing is cheaply done with tanks mounted on street cars—as in Worcester and other Massachusetts cities—it is evident that most of the flushing will be done with tanks drawn by tractors or mounted on motor trucks.

Street flushing is usually done at night; hence it becomes practicable to work motor tractors two shifts daily. In the day time the tractors can haul garbage and refuse wagons, and at night the same tractors can haul flushers and street sweepers. The city of New York has just purchased 34 Garford motor tractors to be used in this way.

Double shift work cuts in two the interest charge per mile of haul and correspondingly reduces the item of garage rental. Let our readers bear this in mind when estimating the saving to be effected by tractors as compared with horses for work of this kind.

In order to decrease the cost of street cleaning and at the same time to increase the effectiveness of street flushing, smoother pavements must be laid on many streets. There are today thousands of miles of pavements that not only are a disgrace to our cities but a constant menace to health, to say nothing of the increased cost of delivering goods over them. Every civil engineer and street superintendent should make it part of his public duty to take the initiative in a campaign to revise city ordinances so that street improvement costs will be assessed upon the entire property within the city rather than upon abutting property owners; for, until the change is effected, progress in street improvement will be relatively slow.

Editorial Comments

Only slightly more than 10 per cent of the total road mileage in America can be classed as "surfaced roads"—that is, surfaced with gravel, sand-clay or some better form of wearing coat. In England there is said to be not a single unsurfaced mile of road. It may be some years before we attain England's road condition, but we are at last headed that way.

Although it is easy to specify that gravel and sand shall be of such and such sizes and free from such and such amounts of loam and dirt, it often costs a pretty penny to secure the specified material. Contractors will do well to assure themselves that the specified materials for a road are available, for engineers are not always careful to draw specifications that fit the local conditions. Then there follows trouble for somebody, and the somebody is usually "the party of the second part."

During the last three years nearly $16,500,000 has been raised for road building by bond issues in 31 counties of West Virginia, or at the rate of $5,500,000 a year. Success in arousing the public to enthusiasm for the issue of road bonds is largely attributable to A. D. Williams, Chief Road Engineer of the State Road Bureau. Mr. Williams has shown in a striking manner what an energetic engineer can do to promote the building of improved roads by educating the public and by showing how slight the burden is under a bonding plan.

It is estimated that nearly $100,000,000 will be spent this year for roads in 16 southern states. If the South was a long time in waking up as to the economy of good highways, she is evidently not going to sleep again.

Billy Sunday and Engineers

To the Editor: I was much interested by the editorial in your July 25 issue entitled "We Need an Engineering Billy Sunday in our Midst." Sunday, by the way, is one of the few preachers that speak of civil engineers in their sermons. In one of them he mentions the awful bridge disaster at Ashtabula, O., stating "in casting the great steel girders they saw there was a defect in one of the moulds and particles of air crept in with the metal and left a space several feet long. The cracks were filled up with a preparation, the beam put in place, and there it stood. On a certain stormy night a train dashed on the bridge, it trembled and down it went, 87 lives being lost."

Not a technical description, but one that hearers can understand.

Sunday's picturesque description of the stone bridge over the Conemaugh River at Johnstown, Pa., which withstood the memorable flood is also interesting:

"Years and years ago (1888) a civil engineer received an order from the Pennsylvania Railroad Co. to build the best bridge at a certain point, that his mechanical skill could produce. He started to dig deep and lay the foundation on the base of the mountain, and some of the old engineers were jealous of his success and said: 'Throw in some concrete and it will do just as well.'

"Said he: 'The company is constantly increasing the number of its trains and the rest of its rolling stock and I do not know what this bridge will be called upon to endure, but I will build the best I know how.'

"He created that bridge and there it stood for years, with nothing more than the ordinary weight of trains, passing back and forth to test it.

"Away back on the Allegheny mountains, was an artificial lake three miles long, a mile wide and in some places 100 to 150 ft. deep made by the millionaires of Pittsburgh.

"Twenty-nine years ago it drizzled and rained for two weeks, day and night, until every rivulet and rill was a roaring torrent. Then the dam holding back this lake broke. The water cut great gulleys that you could have dropped this tabernacle into. It took great rocks that weighed unknown tons. The water swirled against that bridge, and it never moved.

"It reached out one of its venomous arms and picked up part of that little city (Johnstown) and hurled it against the bridge, but it never moved."

Had this bridge failed, perhaps the lives of 3,000 human beings might have been saved. But its impregnable construction caused the formation of a dam, and to the impounded water behind can be attributed the greater part of the frightful loss of life.

This is a case where the engineer "builded better than he knew."

Emile Low.

Buffalo, N. Y.

Cold Bituminous Mixture for Wood Floor Highway Bridges

By B. H. PIEPMEIER

Maintenance Engineer, Illinois State Highway Department.

The Illinois State Highway Department for the past 4 years has been using a bituminous mastic for covering old bridge floors. The mastic surface has been recommended only where the existing structure was too good to destroy and where it would not carry the additional dead weight of a new concrete floor.

The first mat surfaces used were placed by successive application of a hot bituminous material, similar to that ordinarily used for bituminous macadam construction, and torpedo gravel or stone chips.

Emulsified Asphaltic Concrete Wearing Surface Being Applied 1½ In. Thick on an Ordinary Plank-Floor Bridge Under Traffic.

The past year the maintenance department devised the scheme of utilizing an emulsified asphalt for the bituminous compound. The emulsified asphalt permits the application of a bituminous mixture on various isolated bridges where it is not convenient or economical to secure heating apparatus. The emulsified asphalt and aggregate can be mixed in an ordinary concrete mixer, thereby getting a good dense bituminous concrete. The use of emulsified asphalt prevents the use of a surplus of material that may cause creeping, bleeding or leaking of the binder between the bridge plank during hot weather.

Condition of Asphaltic Concrete Wearing Surface After Traffic Has Used Bridge for 10 Days. The Mastic Surface Reduces Impact and Prevents Wear and Decay of Plank.

The cold bituminous mixture for bridge floors was first used by this department in September, 1916. The floor covered last fall was the ordinary 3-in. oak uncreosoted. The wearing surface passed through the winter in first class condition and is now in good shape. Indications are that such surfaces can be constructed and maintained at a cost very much less than would be required for replanking the bridges every few years. The mastic wearing surface adds but very little dead load to the bridge and this is compensated for by the reduction in impact.

The mastic surfaces can be maintained by an occasional surface application of bituminous material and gritts, the same as an ordinary bituminous road surface. If maintenance is properly attended to, it is expected that ordinary uncreosoted oak flooring will last at least 10 years. This being true it would hardly seem necessary to provide creosoted lumber for old bridge floors. In case such a floor was placed on a new structure it would seem advisable to require creosoted subplank. There is considerable advantage in the use of shiplap bridge plank as this will practically eliminate the calking required between ordinary planking.

The following cost data were recently obtained in applying a surface on the plank floor of the Shippingsport bridge near LaSalle, Illinois:

Condition of Bridge.

Total length of bridge, 813 ft.

Width of roadway, 18 ft.

Traffic 25 per cent steel tires, 15 per cent motor trucks, 60 per cent auto traffic. (These figures are approximate only.)

Total traffic, approximately 1,500 vehicles daily.

Average life of 3-in. oak flooring on bridge, 18 months.

New 3-in. oak floor laid in fall of 1916.

Mastic Wearing Surface.

Placed June 11 to 16. Bridge was not closed to traffic.

Aggregate used: Crushed stone chips, ¾ in. to dust, with the dust removed; 20 per cent concrete sand added.

Amount of emulsified asphalt used per cubic foot of material, 1 gal.

Asphalt sand and stone chips mixed in an ordinary batch mixer.

Total square yards of surface treated, 1,146.

Average thickness of mastic, 1½ in.

All cracks calked with lath, shingles and burlap.

Labor, 40 ct. per hour; teams, 80 ct. per hour.

Cost per Square Yard of Cold Bituminous Mix Applied on 1,146 Sq. Yd. 1 In. Thick.

	Per sq. yd.
Superintendence	$0.085
Calking	.086
Cleaning	.008
Stone chips	.093
Sand	.019
Emulsified asphalt, 15.6 ct. per gal. delivered at bridge	.197
Mixing and placing	.116
Total cost, excluding contractor's profit	$0.604

Gravel Road Maintenance by Scarifying, Shaping and Re-rolling

McHenry County, Illinois, unable to maintain its gravel roads under what is really too heavy traffic, by the ordinary methods, has adopted a new scheme which, so far, promises good success. A road roller equipped with a scarifying blade, is run over the road, tearing the surface loose to about 4 in. The blade grader then shapes the loosened material and the roller completes the job. The result is about the same as constructing a new surface for the road. The service Bulletin of the Iowa State Highway Commission states that the same method of using the scarifier to tear up the surface is used in Iowa to remove the humps and wavy effects due to careless gravel road construction which prevails in so many sections of the state. Eagle Grove road builders in Wright County, Iowa, have torn up the surface of a good many miles of humpy gravel road, smoothed up the loosened material, and given it another chance to pack more evenly under traffic.

In 1916 there was expended for roads and streets in California a total of $33,545,000, according to the state controller's annual report. About 28.5 per cent of this was for city streets, 23.5 per cent for state roads and 48 per cent for county roads. County road work in California has become increasingly important, in spite of—and perhaps because of—the increasing sums spent by the state itself.

Causes of Spring Breakups of New York State Highways

Unusual conditions in the maintenance of improved highways in New York State developed last year. During the spring months improved surfaces broke through under traffic to an extent never before experienced in the history of the State Highway. Over 758,000 sq. yd. of pavement were thus broken up. This yardage is equivalent to 82 miles of 16 ft. paved surface. Interesting conclusions as to the cause of these breakups are given by Mr. Fred W. Sarr, Second Deputy State Highway Commissioner, in charge of the Bureau of Maintenance, Repair and Reconstruction, in his annual report, an advance copy of which was given out recently.

The general method used in repairing these broken pavements is to excavate the area involved about 12 to 15 in. in depth, and lay a foundation of rough stone or coarse gravel 9 to 12 in. in depth and restore the pavement on the new foundation, also providing subdrainage for the affected area.

The cost of such permanent repairs will average about $1.30 per square yard. It is, therefore, evident that the cost of permanently repairing the pavements that were broken up last spring in the manner described, including new foundation, would have been approximately $1,000,000.

In many counties the limited funds available would not permit of the permanent repairs described, and the broken pavements were simply leveled down and veneered over with a thin crust of macadam. The field engineers who made the surveys of the broken pavements were requested to designate a reason or cause for the breakup, and of the reasons assigned 50 per cent were accredited to poor drainage. This answer is one that is most easily assigned and readily accepted as the cause of broken pavements which develop during the spring months.

This reason, however, states Mr. Sarr, will not explain why the roads break up in the spring and not during a protracted rainy period in the fall, or why they break up some seasons and not in others.

The conclusions of Mr. Sarr are that the conditions favorable to broken pavements in the spring are a wet season the previous year followed by an open winter or one with repeated freezing and thawing; the effect of these conditions on a silt sand or soft clay produce an unstable condition when the frost finally leaves the ground, and if the pavement crust has not sufficient strength in itself to bridge over the unstable section and carry the traffic loads, there is but one answer—a broken pavement.

The act of freezing of the material forming the foundation of a pavement draws moisture from below. This is demonstrated by freezing of a reasonably dry earth surface which, after thawing, leaves a wet muddy surface.

Following a wet season the level of the ground water is high, perhaps at the elevation of the bottom of the open ditches. The act of freezing draws this water up to the under side of the pavement which, if impervious, is heaved or raised by the expansion of the moisture by freezing. The frost goes out, but before the moisture can leach away, another freeze occurs, more moisture is drawn up, more heaving occurs. It is not uncommon to find pavements heaved 4 to 6 in. with not over 18 in. of frost.

The expansion of water by freezing is about one-eleventh. It is, therefore, evident that the extreme heaving is due to something other than the expansion of the moisture which was naturally in the crust actually frozen.

It is, therefore, concluded that the act of freezing and thawing draws up, from the ground water level, moisture which accumulates under the impervious pavement in frost or ice, thereby lifting or heaving the pavement.

This action may be observed with many classes of soils, but only in certain cases will the pavement break through.

When the frost finally leaves the ground in the spring there is an accumulation of water in the frost affected area, and with soils that of their nature by capillary attraction hold the moisture in suspension, they become semi-plastic and unstable. Soils that are not suited to the capillary action permit the moisture to leach away and settle down much quicker and then have stability to sustain the pavement under moderate traffic.

The soil most productive of broken pavements is a silt sand found in the valleys. This material when examined with a microscope is found to be made up of round fragments of rock mixed with a varying quantity of silt or when dry an impalpable powder. This mixture of rounded sand grains mixed with the very fine powdered silt forms an ideal condition for the retention of moisture by capillary action, and when in a saturated condition is very unstable, and in extreme conditions is styled quicksand.

Traffic over the pavement crust where these conditions prevail causes the pavement to weave, depressing under the load and rising both front and rear; with moderate traffic the thin pavement crust may withstand the weaving without breaking through, the only result being a wavy surface after the moisture has finally leached away.

But with heavy loads traversing the highway during this unstable period the pavement first appears to buckle or bulge at frequent points, after which the destruction is fast; the pumping action of the passing load tends to force the plastic subsoil toward the vent at the bulge, where the pavement eventually breaks in what is termed a frost boil. This break is then extended at each end by traffic, until the small frost boil may extend 50, 100 or more feet in extent.

The most effective construction where these troubles are anticipated is an open porous foundation course of rough field or quarry stone or coarse gravel.

Mr. Sarr prefers the open course to the filled course. The open course permits the accumulation of the frost in the voids without heaving of the pavement, also where the moisture is allowed to accumulate in the voids of the open foundation course, it is not held in suspension by the subsoil, and if the open foundation is provided with suitable outlets, the moisture accumulated under the top crust will drain off quicker, and the underlying subsoil become stable sooner than with the close filled impervious foundation course where the moisture is frozen into the subsoil.

One of the principal reasons for the large amount of broken pavements, developing the past season, is that the pavements were not constructed sufficiently strong to carry during the trying periods the heavy loads to which the highways are now subjected, by reason of the rapid increase in number and weight of commercial trucks and busses, especially where they are operating on regular daily schedules.

A large percentage of the mileage of improved highways in New York State were designed and only intended to carry a gross load of about three tons moving at a speed of 4 miles per hour, and many of these roads are now subjected to gross loads of 7 to 10 tons moving at a speed of 12 to 15 miles per hour.

The division engineers were requested during the past summer to report the improved highways which, in their opinion, were not structurally strong enough to withstand, during the spring months, the traffic to which they are now being subjected, and the total length of improved highways so reported was 1,939 miles, which were improved at a probable cost of $20,000,000 and are now considered not sufficiently strong to withstand the traffic to which they are now subjected, and this traffic, that of the motor truck and bus, is increasing by leaps and bounds, not only the number of such vehicles, but the gross weight of the vehicle.

The 5th Avenue, New York City Pavement and the Traffic Carried

A traffic census completed recently by the 5th Ave. Association, New York City, shows that the total traffic on 5th Ave., at 42d St., New York City, averages 28 vehicles per minute. According to the Association figures, which represent vehicles of all kinds passing the Public Library, between 41st and 42d St., the volume of traffic totals in 10 hours (from 8 a. m. to 6 p. m.) 16,960 vehicles. Northbound and southbound traffic is about the same—8,513 northbound and 8,447 southbound. Included in the total of 16,960 are 1,296 motor busses—130 per hour in both directions. At the point where this census was taken 5th Ave. is 55 ft. wide, which, theoretically at least, permits the movement of six lines of vehicles. The count showed that passenger motor vehicles composed about two-thirds of the traffic, but these included the motor busses, which are heavier than most commercial motor cars.

The pavement carrying this traffic is sheet asphalt, composed of a 1½-in. close binder and 1½-in. top, on a 6-in. concrete base. It was laid in 1913, replacing a similar pavement which had been down 17 years. The analysis of the top mixture used in this pavement shows a high percentage of bitumen and a correspondingly high production of fine material. An average of 11.7 per cent of Trinidad asphalt was maintained throughout the laying of the pavement, although 10.5 per cent was all that was required. The complete analysis of the surface mixture is as follows, the standard being given for comparison with the actual composition of the 5th Ave. pavement:

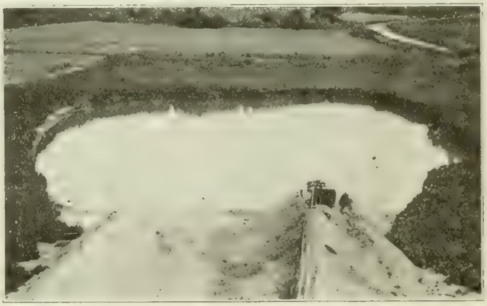
	Standard. Per cent.	5th Ave. Per cent.
Asphalt	10.5	11.7
200 mesh	13	17.3
100 mesh	13	10
80 mesh	13	22
50 mesh	24	23
40 mesh	11	5
30 mesh	8	8
20 mesh	5	2
10 mesh	3	1

The box measurements for the top mixture were 720 lb. of sand, 105 lb. of dust, and 175 lb. of asphalt cement. For the binder course the measurements were 600 lb. of stone, 310 lb. of sand, and 90 lb. of asphalt cement.

County Plant Produces Gravel at Cost of 17.4 Cents Per Yard

After four months of operating their own plant to furnish gravel for building and repairing their county roads, the commissioners of Logan County, Illinois, have found the plan so satisfactory that machinery for a second plant has recently been installed. Their experience should be of interest to other county engineers and highway commissioners.

The first plant is located about three miles west of Lincoln, Ill. The gravel deposit is on farm property and the county has to pay the owner on an acreage valuation for the land destroyed by the gravel operations. It was originally planned to excavate with steam shovel, but preliminary tests showed that water was within a few feet of the surface, and the slack-line cableway method of excavating was decided upon. The pit is now 30 ft. under water and about 20,000 yd. of pit run gravel has been produced in 100 working days this season. About 15,000 more yards will be taken from this pit and then the plant will be moved to another location.



Pit, Stock Pile and Excavator at Gravel Plant of Logan County, Illinois.

The plant consists of a Sauerman dragline cableway with Sauerman excavator bucket of 1 cu. yd. capacity, operated by a 9x10 Thomas steam hoist equipped with band frictions. Power for the hoist is furnished by a 35-hp. vertical boiler. The cost of the plant was $5,500.

The following table, based on figures obtained from Mr. J. C. Wigginton, superintendent of the Logan County pits, shows the cost of excavating 35,000 yd. with this plant, based on the reasonable expectation of completing the present operations in 175 days:

		Per cu. yd.
Erecting and dismantling plant	$ 425	$0.012
Depreciation, at 10 per cent	550	.010
Interest on investment, at 6 per cent	330	.010
Repairs	1,050	.030
Oil and grease	90	.002
Coal (1½ tons daily at $4)	1,050	.030
Superintendent's salary (half time, at $1,500 year)	750	.021
Three laborers' wages ($9.50 per day for three)	1,662	.047
Insurance	100	.003
Incidentals	100	.003
	$6,107	$0.174

This gives a cost of 17.4 ct. per yard, which is very low. However, Mr. Wigginton seems to have taken into consideration every expense. His salary is $1,500 a year and as he divides his time between the two county pits each plant carries half of this expense. The item of his salary in the above table of cost and the items of depreciation and interest are based on a year's operation of the plant, although the 35,000 yd. will not represent an entire season's run. Repairs, chiefly replacing worn track cables and sheaves, are estimated in the above table as averaging 3 ct. per yard of material excavated, which is higher than the per yard repair costs generally accepted for this class of operations in 1914, before the great advances in the cost of wire rope and cableway fittings. No preliminary stripping was necessary in developing this pit. If there had been 4 or 5 ft. of top soil to remove, as is the case in the other county pit, it would have added about $1,000 to the total cost and increased the cost per yard to 20 ct.

The entire output of the county plants will be used for county road work and most of it will be loaded and hauled by the farmers themselves.

The second Logan County plant, located at Deer Creek, 3 miles south of Lincoln, consists of a 1-yd. Sauerman dragline cableway excavator, operated by a 9x10 35-hp. American steam hoist. The Deer Creek gravel pit will keep this plant operating a number of years, and it is the intention to eventually install screens and bins and produce washed material for the county's concrete work. A railroad siding permits of loading and transporting the gravel in carloads to the principal points in the county. This plant is just starting operations.

Bonus for Motor Truck Drivers

The desirability of paying a bonus to motor truck drivers for minimizing waste time and saving on repair expenses was pointed out in our July 4 issue. The experience of one of the largest manufacturers of automobile parts in the country with this bonus plan is described in a recent issue of the Federal Traffic News, a publication of the Federal Motor Truck Co.

The manner in which the bonus was awarded is quite simple. After cost records had been kept for some time a standard cost per ton mile was determined from the averages thus obtained.

Also a maximum cost was determined from the same figures and the driver was offered 50 per cent of the saving between the maximum and the standard.

Example:

(a) Standard cost per ton mile = $0.05.
(b) Maximum cost per ton mile = $0.075.
(c) Operator's actual cost per ton mile = $0.06.
(d) Total ton miles accomplished = 1,800.

The driver's bonus is determined by the formula:

$$\frac{b-c}{2} \times d = \text{bonus},$$

which in this case would be:

$$\frac{.075-.06}{2} \times 1,800 = \$13.50$$

In other words—by careful driving after understanding where and how he can reduce expense and increase efficiency the driver would earn $13.50 per month in addition to his wages. This company has found that high reward will bring high accomplishment. The driver has found that it pays him to serve well.

Eight months of this method in the business of delivering automobile parts using four different makes of trucks has resulted in increased loads (without overloading), high percentage of operating time and decreased cost.

The eight months' results were as follows:

Trucks number.	Ton miles per mo. per cent. Gain.	Cost per ton mile per cent. Decrease.
1	45.4	37.7
2	5.5	13.8
3	3.5	29.8
4	1.5	11.5

No explanation is given by the concern as to the great variation in percentage of gain in efficiency of the different trucks.

Effect of Controllable Variables on Toughness Test for Rock

A study of the standard toughness test for rock has been made recently in the laboratory of the U. S. Office of Public Roads and Rural Engineering. This test was introduced in the United States about 15 years ago by Mr. L. W. Page, and in general has been considered very satisfactory. Certain discrepancies have been noted recently, however, between tests made in the same laboratory on samples from different portions of a rock quarry, as well as between tests made by different laboratories on apparently identical material. These discrepancies would seem to indicate that the variations in the physical properties of rock from the same quarry may be much greater than has been heretofore considered probable, and also that the method of conducting the test is perhaps not sufficiently controlled under the present standard to insure check results in all cases. The investigation was undertaken with a view to determining the causes of these discrepancies. The results of the study are given in a paper by Mr. F. H. Jackson, Jr., presented at the last annual meeting of the American Society for Testing Materials, from which thatter following is taken:

An analysis of the methods now used in making the toughness test shows that discrepancies in results may in general be traced to either (1) the fact that the range in physical properties of the quarry product is so great that it is impossible to obtain an average value for the toughness of the material, with the small size and number of test specimens used in a given determination, or (2) to the fact that certain variables may be introduced during the preparation or testing of the specimen which might affect the result and which are not controlled by the present standard. These considerations are of course entirely distinct from any question of the value of a test for impact, as an indication of the suitability of rock for road-building purposes.

Variations in Toughness of Rock from Same Quarry.—A determination of the probable extent of this variation is very important for obvious reasons. For instance, there is a general impression current among those interested commercially in the production of stone for road work, that the results of a single test, made perhaps several years before, is sufficient from which to judge the quality of a rock quarry. Likewise, in sampling rock for test, it is usually thought sufficient to take a single sample without any particular care being exercised to insure having it represent the only kind of material which it is proposed to use. The results of a few tests of samples from a number of well-known quarries, which have been in operaton for some years, are given in Table I, and show the wide range in toughness which it is possible to obtain on material from the same quarry. Although all of these tests were made in a single laboratory, using the same testing machine and tested in most cases by the same operators, and were therefore pre-

TABLE I.—VARIATION IN TOUGHNESS OF ROCK FROM SAME QUARRY.

Samples Taken at Different Times.

Location of quarry.	Kind of rock.	Toughness; height of fall causing failure, cm. Test No. 1	2	3	4	5	6
New York	Trap	27	27	17	33	21	[illegible]
New Jersey	Trap	27	33	30	..	..	..
Pennsylvania	Trap	12	26	17	13	..	..
Ohio	Limestone	18	9	6	7	..	..
Ohio	Limestone	16	11	10	..	..	..
New York	Limestone	9	7	13	13	..	..
Maryland	Schist	20	19	34	30	44	.
North Carolina	Granite	13	14	9	10	10	11
New Hampshire	Granite	7	9	8	8	..	..

sumably made under fairly uniform conditions, it is quite possible that some of the variations indicated are due to a failure to appreciate, and therefore control, variables introduced during either the preparation or testing of the specimens. In order to throw some light on this point, the actual variations in the quality of the product of several quarries were studied under as nearly as possible identical conditions.

Table II gives results showing the possible variation in toughness of several typical rock quarries when the samples are taken at the same time from different portions of the deposit. These results are of principal interest in showing the wide range in toughness possible to obtain on samples taken from different portions of the same quarry, even when the material quarried is considered to be very uniform in quality, which is the case in both the trap-rock and granite quarries examined. In the case of two of the trap-rock quarries, there was also noted a considerable variation in the toughness of the individual specimens composing a sample. The individual breaks are given in Table III in connection with the study of the effect of direction of drilling on toughness.

It was noted at the time the trap-rock specimens were broken, that the ones showing the most irregular fracture at failure were in general the ones showing the lowest results, even when there was absolutely no visible line of weakness before failure. The appearance of these peculiar fractures would seem to indicate that there may be present in some rocks, a great number of minute planes of weakness, running in all directions and formed possibly at the same time and in much the same way as the large joint planes with which the quarryman is familiar. The variable toughness shown by different specimens cut from the same piece might also be caused by the formation of incipient fractures in the mass due to blasting. Conditions such as these are emphasized by the comparatively small-size test specimens and might form an argument for the adoption of a larger size. When we consider, however, the increased cost of and the time necessary to prepare larger specimens, it would appear advisable to use the present size, and to obtain an average value for the toughness by making a larger number of tests than is at present customary.

In the case of the granites examined, much greater uniformity was observed, not only between different samples from the same quarry, but also between individual specimens taken from the same sample. The limestones tested represent probably the extreme of non-homogeneity apt to be found in ordinary road-building rock and are given for this reason. Each of these materials was extremely non-homogeneous in appearance, individual pieces running from fairly tough, fine grained rock to portions showing a high percentage of argillaceous material, which runs of course much lower in toughness. It is obvious that the only way to obtain average values for the toughness of material from deposits such as these, is to exercise extreme care in selecting samples to insure that all variations in quality are represented. This would, of course, entail more work than the mere picking of a single sample, which is common practice.

An interesting feature in connection with the limestone tests is the fact that considerable variation was also noted in even the standard abrasion test, which utilizes a very much larger sample. In the first case two abrasion tests gave French coefficients of wear of 13.3 and 10.5; in the second case, 12.1 and 10.3; and in the third case, 18.2 and 10.5.

The results given in Table II are presented for the purpose of showing quantitatively the possible bearing on the test result of lack of care in sampling. Unless there is reasonable assurance that the material tested is representative, no amount of care in the preparation and testing of the individual samples can be expected to secure reliable results.

Variables Introduced During the Preparation of the Test Specimen.—Variables occurring during preparation of the test specimen may include (1) effect of direction of drilling specimens with reference to any possible plane of structural weakness, such as rift, bedding plane, or plane of foliation; (2) effect of size of test specimen, either in diameter or height; (3) effect of moisture content; and (4) effect of lack of care in preparation of specimen, such as failure to

TABLE III.—EFFECT OF DIRECTION OF DRILLING SPECIMEN ON TOUGHNESS.

Location of quarry.	Kind of rock.	Sample set.	Toughness; height of fall causing failure, cm. — Specimen No. 1	2	3	4	5	6	Av.
Pennsylvania	Granite	A	9	8	9	11	9	8	9
Pennsylvania	Granite	B	9	11	10	10	11	10	10
Pennsylvania	Granite	A	8	6	6	7	7	6	7
Pennsylvania	Granite	B	7	5	6	7	6	8	7
Maine	Granite	A	7	9	8	8	9	8	8
Maine	Granite	B	10	9	8	9	7	..	9
Virginia	Granite	A	8	7	5	4	6	6	6
Virginia	Granite	B	6	6	7	6	6	6	6
Massachusetts	Granite	A	10	7	9	8	10	8	9
Massachusetts	Granite	B	8	8	10	9	11	11	10
Maine	Granite	A	10	11	10	12	11	12	11
Maine	Granite	B	10	10	12	10	10	11	11
North Carolina	Granite	A	8	9	7	6	6	7	7
North Carolina	Granite	B	5	5	7	6	6	8	6
Maine	Granite	A	7	7	7	6	6	..	7
Maine	Granite	B	9	8	9	7	6	7	8
New York	Gneiss	A	13	12	12	12	16	11	13
New York	Gneiss	B	6	7	6	6	6	7	6
Maryland	Schist	A	32	30	30	..	..	..	30
Maryland	Schist	B	16	12	[illegible]	..	..	..	12
New York	Limestone	A	13	14	13	..	..	..	13
New York	Limestone	B	12	10	12	..	..	..	12
Indiana	Limestone	A	11	12	10	10	..	..	11
Indiana	Limestone	B	9	10	12	10	..	..	10
West Virginia	Sandstone	A	11	13	10	13	9	13	12
West Virginia	Sandstone	B	9	8	8	9	7	6	8
....	Sandstone	A	11	12	11	9	11	11	11
....	Sandstone	B	11	10	11	11	10	10	11
Virginia	Sandstone	A	10	10	10	9	10	..	10
Virginia	Sandstone	B	7	7	7	7	..	..	7
New York	Trap	A	21	17	21	17	19	19	19
New York	Trap	B	21	19	25	23	19	20	21
New York	Trap	A	22	19	20	20	22	..	21
New York	Trap	B	19	19	26	16	20	..	20
New Jersey	Trap	A	27	27	28	30	38	..	30
New Jersey	Trap	B	24	29	25	30	27	..	27
New Jersey	Trap	A	32	33	32	39	33	35	34
New Jersey	Trap	B	34	33	36	38	..	..	35

A, Specimen drilled perpendicular to the direction of laying in the street. B, Specimen drilled in the direction of laying in the street.

TABLE II.—VARIATION IN TOUGHNESS OF ROCK FROM SAME QUARRY.

Samples Taken at Same Time.

Location of quarry.	Kind of rock.	Average toughness; height of fall causing failure, cm. — Specimen No. 1	2	3	4	5	6	Gen. av'ge.	Max. variation.
New York	Trap	20[1]	20[2]	15[2]	22[3]	..	..	19	7
New Jersey	Trap	29[2]	33[4]	35[2]	..	..	..	32	6
Maryland	Trap	20[5]	10[5]	20[5]	..	..	..	20	1
Maine	Granite	18[6]	16[6]	16[6]	..	..	..	17	2
Massachusetts	Granite	9[6]	10[6]	10[6]	..	..	..	10	1
Maryland	Granite	10[7]	10[8]	10[7]	..	..	..	10	0
Ohio	Limestone	12	7	8	14	..	12	12	9
Ohio	Limestone	6	8	7	6	6	5	6	3
Ohio	Limestone	12	8	6	9	11	10	9	6

[1] Average of 12 specimens. [2] Average of 10 specimens. [3] Average of 11 specimens. [4] Average of 8 specimens. [5] Average of 5 specimens. [6] Average of 2 specimens. [7] Average of 3 specimens. [8] Average of 4 specimens.

have perfectly plane bearing surfaces, or ends absolutely perpendicular to the axis of the cylinder.

With reference to the first point it has been the custom in most laboratories to drill specimens from a rock sample at random, except in cases where well-developed, visible planes of foliation appear, in which case specimens are usually taken perpendicular to the foliation. The question has been recently raised, however, whether other materials might not possibly have planes of weakness, which would cause specimens drilled in one direction to fail sooner than those drilled in the other direction. Thus, granites drilled along the rift, and sedimentary rocks, such as limestone and sandstone drilled along the bedding plane, might show lower toughness values than when drilled in other directions. The results of the study along this line are given in Table III.

The eight granites examined represented material from some of the best known granite quarries in the United States. In each case, results recorded under sample set A were obtained on material drilled perpendicular to set B. The samples were full-size paving blocks, and the individual specimens were drilled along the two short dimensions; sample set B being drilled in the direction of laying in the street. It is seen at once that there is very little difference in the average toughness of sets A and B. In fact the difference is so slight as to be practically negligible.

When we come to the foliated types, however, as represented by the gneisses and schists, we find as would be expected, a large difference in toughness, the specimens drilled perpendicular to the foliations being in one case twice, and in the other case almost three times as tough as those drilled parallel to them.

In regard to the sedimentary rocks, only slight variations are noted, with two exceptions, namely, the first and third sandstones tabulated. Both of these materials showed thin, well-developed planes of bedding. In the case of the other sandstone, as well as both of the limestones, the stratification was not nearly so well marked. These results indicate that in certain cases at least, the bedding plane of sedimentary rocks must be considered in preparing specimens for test. In the case of both the sedimentary and foliated types, the specimens of set A were drilled perpendicular, and the specimens of set B parallel, to the plane of weakness.

The results on four samples of trap rock are also given, and indicate very little difference in toughness due to the direction of drilling. The two sets of specimens in these cases were drilled perpendicular to each other, without any reference to the natural bed of the stone, since true bedding, so-called, does not exist in the massive trap-rock formations. The individual results of breaks given in Table III indicate the possible variations in toughness of different specimens taken from the same piece, and tested under identical conditions.

TABLE IV.—EFFECT OF DIAMETER OF SPECIMEN ON TOUGHNESS.

Location of quarry.	Kind of rock.	Diam., mm.	Toughness, height of fall causing failure, cm. —Specimen No.— 1	2	3	4	5	6	Av.
Ohio	Limestone	18.0	2	3	2	3	3	3	3
Ohio	Limestone	23.5	2	3	3	3	..	..	3
Ohio	Limestone	24.5	3	3	3	3	..	..	3
Ohio	Limestone	25.0	3	2	3	3	..	..	3
....	Sandstone	18.5	8	6	7	7	6	7	7
....	Sandstone	23.0	9	9	8	8	9	6	8
....	Sandstone	24.0	11	10	11	11	10	10	11
....	Sandstone	25.0	13	13	11	11	12	13	12
Maryland	Granite	19.0	5	7	6	6	6	7	6
Maryland	Granite	24.0	11	10	10	11	10	10	10
Maryland	Granite	25.0	12	12	11	12	13	15	13
Maryland	Trap	19.0	16	16	15	14	15	..	15
Maryland	Trap	23.0	19	19	19	20	..	..	19
Maryland	Trap	24.0	20	18	21	21	..	..	20
Maryland	Trap	25.0	23	22	22	22	24	21	22
Maryland	Trap	26.0	25	27	27	26	..	..	26
....	Granite	23.0	8	8	7	6	8	..	8
....	Granite	24.0	10	10	9	9	10	..	10
....	Granite	25.0	11	11	11	10	..	..	11

The reason for the large number of tests of granite compared to the other types is because of the possible desirability of using this test in connection with the use of granite in stone-block construction. As may be seen, there is not only considerable range in toughness of the different granites tested, but the individual specimens in every case lie very close to the average, which indicates that it should not be a difficult matter to obtain check results.

Variation in both the diameter and height of a test specimen should at first sight be easily controlled during its preparation. Experience has shown, however, that it is practically impossible to manufacture diamond drills which will drill cores of constant diameter, the wearing away of the diamonds resulting in producing cylinders of gradually increasing diameter. This condition naturally results in tests being made on specimens covering a considerable range in diameter with consequent possible variation in result. In Table IV are given the results of a study of the effect of this variable, made with the view of determining how great a permissible variation in diameter should be allowed.

Five materials showing different degrees of toughness were examined and in all cases but one, marked variations were observed. For instance, in the case of the trap-rock an increase of 3 mm. in diameter resulted in an increase in toughness of 36 per cent. In the case of the sandstone, a difference of 2 mm. in diameter resulted in a 50 per cent increase in toughness. These variations would go far towards explaining the discrepancies, even assuming all other valuables to be of negligible importance, and certainly shows the necessity of maintaining the diameter of the specimen at as near 25 mm. as possible. The experience of the author covering a period of several years in the government laboratory would indicate that a permissible variation of less than 1 mm. would not be practical from the standpoint of drill manufacture. No greater latitude should be allowed, however, under any circumstances.

The matter of height of specimen is, of course, not difficult to control, since it is a comparatively simple matter to prepare cylinders almost exactly 25 mm. long. A few comparative tests were made, however, which indicated that a range of as much as 1 mm. might be allowed without affecting the result.

Conclusions.

The following points in connection with the work described may be noted:

1. In judging the quality of a rock quarry from the results of a single test, the fact that large variations in toughness may occur from time to time should be borne in mind, and an effort made to secure a test of the material at approximately the same time that the material is to be used.

2. Great care should always be exercised in selecting samples for the toughness test, because the product of a rock quarry of even apparently uniform quality is apt to vary, throughout different portions of the face.

3. In preparing samples for the toughness test, the following points should be kept in mind and the operator governed accordingly:

(a) In every case where planes of foliation as in all gneisses and schists, or planes of bedding as in many sandstones and some limestones, are visible, specimens should be drilled as nearly at right angles to the plane of weakness as possible. Another set of specimens should also be prepared from samples drilled parallel to the plane of weakness;

(b) No core drill should be used which drills specimens with a greater total variation than 1 mm.;

(c) Variations in the height of specimens may be as great as 1 mm. without practically affecting the result;

(d) Variations in the moisture content of specimens apparently do not practically affect the result. For the sake of uniformity, however, all specimens should be dried in an oven prior to testing; and

(e) The greatest possible care should be exercised in the preparation of the specimen, so as to insure perfect bearing surfaces absolutely perpendicular to the axis of the cylinder.

4. Very little injury is done to a specimen during the progress of the test as a result of vibrations of the plunger.

5. The total energy of the blow required to cause failure is not influenced by secondary blows of the hammer, produced by its rebound after striking the plunger.

Methods of Installing Expansion Joints

A special steel stake is used by Jensen & Krage, Contractors, Sioux City, Ia., in connection with the installation of premolded, sandwich type, expansion joints, for concrete pavements. The arrangement is described in the Concrete Highway Magazine, from which this note is taken:

In setting a joint, a line is stretched across the street at the desired location. A 2 by 6-in. temporary header is staked to the line, using the steel pins on the side away from that on which the joint will be placed. The stakes are driven down until the outstanding lug bears on the upper edge of the header. The joint filler is then laid against the header and staked in place with the steel pins, the lugs bearing only on the upper edge of the joint filler. After concreting a foot or so beyond the joint, the stakes holding the header are pulled, thus permitting its removal. The joint is still held by the remaining stakes which are not pulled until concrete has been tamped into the space left by the header.

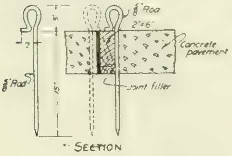


Fig. 1.

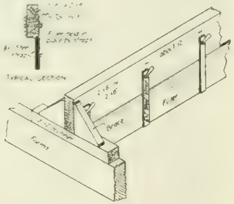


Fig. 2.

Another method of installing joints uses the special arrangement shown in Fig. 2. A 2 by 6 plank is fastened and firmly braced to wooden runners which ride on the side forms. Specially shaped pieces of strap iron are fastened about 1 ft. apart to one side of the 2 by 6. The joint material is gripped against these by removable iron straps, on the opposite side of the plank, held in place by wing nuts.

In using this arrangement, the joint material is securely clamped between the irons, and concrete is then placed on both sides. The wing nuts are then loosened, thus permitting the plank to be removed, leaving the joint in place.

Military Road Construction in France

An interesting description of the methods employed in constructing roads behind the battle front in France is given in a letter received recently by Mr. George C. Warren, president of Warren Bros. Co., Boston. The writer, W. G. Mackendrick, president of the Warren Bituminous Paving Co., Ltd., of Ontario, has been engaged for the past two years on military road construction at the front in France and Belgium. He went abroad privately as a civilian, tendered his services to the British government and was first commissioned captain in charge of a detachment of Canadian Volunteers; he later was advanced to major and recently to Lieutenant Colonel. Extracts from his letter follow:

All the roads in France and Belgium are macadam or macadam with stone setts on sand in the center of roads except in the towns and villages where the main streets are mostly stone setts, or Pavic, as they call them here. Nearly all French roads are very light construction—from 4 to 6 in. of gravel or stone and a few inches of chalk or sand. They do not stand up under the intensive traffic in the army areas of the 3 and 5-ton lorries, guns, etc., and in the spring, fall and winter it is a case of strengthening them with macadam, slag, mine refuse, chalk, old soft bricks from the destroyed villages, or anything that can be had. On bad places, wet and swampy, we use sleeper roadways, i. e., railway ties on three bearers spiked down, or 3-in. plank roads or three bearers or corduroy roads similarly built.

When building roads in France or Belgium we used to adopt Macadam's method of standing large stones on end, hand placed and then breaking off the tops and placing macadam on top and rolling, but I found for this climate on wet soil this method was very expensive, as the huge lorries drove the stones down into the mud and it kept on sinking, so I adopted the method of laying the large stones, or soling, as they call it here, on its flatest side to give good bearing so it would carry the lorries better and then filling the macadam on top of this in dry weather, rolling and consolidating as usual and binding with mud off the side of the road in wet weather, first placing the soling with more on top, and letting the traffic wiggle it into shape. No rollers are used in winter, as they block traffic too much and are unnecessary.

The road from Albert to Bapaume was rebuilt and recoated in this way and we carried all the army on it without a roller on the road until the dry weather of May, when we started to put a regular coating of macadam on it and had eight rollers working two shifts per day licking it into shape.

Time is the factor in all advance road work such as is only possible in these armies, as from the minute an advance is made by the infantry the guns must go up in support and the munitions must go up constantly thereafter, and whatever can be got to make the roads usable is the thing for the army. We carried all the roads in the recent advance for many weeks with repairs made to all the shelled sections, which in the worst spots comprised from 80 to 90 per cent of the road near and in villages with the bricks and building chalk from the destroyed buildings in the nearest village. The traffic grounds this material into powder and in wet weather into mud and it had to be renewed every day or two, but with stone costing 30 shillings a ton and at any price not available we had to use what we could get. We have built many miles of railway sleeper roads for temporary use.

Cost never enters into the question here when we are moving whatever we can get that will hold up the guns and traffic is used. Trees are used, old sleepers, rafters and so forth from houses in the demolished villages are laid down to enable the guns and regiments to get along and keep moving and in many cases we could only make roads good enough for the horses to pull in the ambulance carts and limbers could not be taken in over the only available roads until many days of weeks' work had been put on them. I have had 10,000 to 12,000 men working for many months and have used up to 2,000 tons of metal a day, not counting corduroy, sleepers or pit props or brick; when possible we fill all holes with broken bricks and fill 4 to 6 in. macadam on top for a wearing surface and all the while we must keep the traffic moving usually two ways on roads 16 to 18 ft. wide.

3,512,996 Motor Cars in United States in 1916

In 1916 a total of 3,512,996 motor cars—including commercial vehicles—and 250,820 motorcycles were registered in the United States, according to a circular prepared by the Division of Roads Economics, U. S. Office of Public Roads, and issued last month. The state collected in registration and license fees, including those of chauffeurs and operators, a total gross revenue of $25,865,369. As compared with 1915, this was an increase of 1,067,332 cars, or 43 per cent, in number, and $7,619,659, or 42 per cent, in revenue. This corresponds very closely to the annual percentage increase of the three preceding years, which was about 40 per cent for motor cars and 50 per cent for revenues.

In 1906 the total state registrations were approximately 48,000 cars, on account of which the several states collected in fees and licenses a total gross revenue of about $193,000, a sum equal to less than three-tenths of 1 per cent of the rural road and bridge expenditures for that year, but of which only a small portion was applied to road work. In 1916, however, of the total gross motor vehicle revenues, amounting to $25,865,370, or a sum equal to about 9 per cent of the total rural road and bridge revenues, 92 per cent, or $23,910,811 was applied directly to construction, improvement or maintenance of the public roads in 43 states. Of the total amount applied to road work, about 70 per cent, or $16,411,520, was expended more or less directly under the control or supervision of the state highway departments. The 7½ per cent, or $1,954,559, not applied to road work was expended very largely for tags and in carrying out other administrative provisions of the various motor vehicle registration laws of the several states.

In 43 states all, or the major portion, of the motor vehicle revenues collected in 1916 were expended for the construction, improvement or maintenance of the public roads, or for the maintenance of the state highway departments. In the states of Alabama, Delaware, South Carolina, Texas and West Virginia, and the District of Columbia this requirement did not exist.

As the number of motor vehicles registered under the general designation of automobiles, motor trucks and commercial vehicles in continental United States in 1916 was 3,512,996, and the total road mileage of the United States outside of incorporated towns and cities was 2,445,761 miles, there was an average of 1.4 motor cars for each mile of rural public road in the United States. But the distribution of the motor cars among the several states was far from uniform. There was only about 1 motor car for every 3½ miles of rural road in Arkansas, while in Massachusetts and New York there were 7.3 cars per mile of such road, and in Rhode Island the density reached 9.8 cars per mile. While there was an average of 1 motor car registration for every 32 persons in the United States, in the state of Iowa there was 1 for every 11 persons, but only 1 for every 116 in Arkansas.

While there seems to be a general tendency to increase the registration fees required for motor trucks, there is as yet no well-developed and definite basis for determining in a logical manner the fees to which the different cars shall be subject. In some states the fee is based on the net weight of the vehicle; in others, the carrying capacity, the horsepower, or some combination of these factors is used. The amount of fees collected per car, whether pleasure or commercial, is as yet far from uniform, and is still further complicated by the widely varying requirements for the registration of licensing of chauffeurs, owner operators, dealers, etc. Thus, if the total registration and license fees be used as a basis of revenue, and the total number of automobiles, trucks and commercial vehicles as a basis for motor cars, it is found that for the entire United States the average fee per motor car was $7.36. On the same basis the state of Vermont secured in 1916 a gross revenue of $19.02 for every motor car, while Minnesota received only about 50 cents annually for each car, as the registration is for a three-year period. Furthermore, in Texas and South Carolina, no annual registration fees were collected, the only requirement being a county fee of 50 ct. and $1, respectively.

General Limiting Test Values for Broken Stone

A table of general limiting test values for broken stone has been adopted by the U. S. Office of Public Roads and Rural Engineering. These limiting values, together with comments upon limits shown, are given in Table I, which is taken from a recently issued bulletin of the U. S. Department of Agriculture.

Cementing values should show over 25 in all cases if material is to be used in water-bound macadam construction. In general, granites, gneisses, schists, sandstones, and quartzites should not be used in the wearing course of water-bound macadam roads. Shales and slates never should be used in this connection; therefore cementing value tests have been discontinued on these materials.

TABLE I.—GENERAL LIMITING TEST VALUES FOR BROKEN STONE.

Type of construction.	Traffic.[1]	Limiting values. French coefficient of wear.	Toughness.	Hardness.
Water-bound macadam, plain or with dust palliative treatment	Light	5 to 8	5 to 9	10 to 17
	Moderate	9 to 15	10 to 18	14 or over
	Heavy	16 or over	19 or over	17 or over
Macadam with bituminous carpet	Light to moderate	5 or over	5 or over	(2)
Bituminous macadam with seal coat	Moderate to heavy	7 or over	10 or over	....
Bituminous concrete	Light to moderate	7 or over	7 or over	(2)
	Moderate to heavy	10 or over	13 or over	....
Binder course for sheet asphalt or Topeka type	Any	7 or over	6 or over	(2)
Portland cement concrete	Moderate to heavy	(3)	8 or over	16 or over
Stone paving block[4]	Any	(3)	9 or over	16 or over
Broken stone foundations	do	3 or over	3 or over	8 or over
Cement concrete foundations		....	....	....

[1] Light traffic is assumed as less than 100 vehicles per day, moderate traffic between 100 and 250 vehicles, and heavy traffic over 250 vehicles per day.

[2] Numerous tests have shown that limits for hardness are unnecessary if the material possesses the required French coefficient of wear and toughness.

[3] Limits for French coefficient of wear are not at present considered necessary for this type of construction.

[4] Crushing strength, 20,000 lbs. or over per sq. in. is sometimes required.

Military Road Construction at Mt. Gretna, Pa.

Extensive use of road building equipment enabled the Pennsylvania Highway Department to construct improved roads at the Mount Gretna camp site of the National Guard in record time.

The work on the road building project commenced on July 1 and the schedule called for the completion of 2 miles of waterbound macadam road, 15 ft. wide, each week, until the 6½ miles, required by the military authorities, were completed.

Brushing Right of Way, Colebrook Section, Mt. Gretna Military Road.

The State Highway Department commenced to assemble its forces and equipment immediately after the request of the Adjutant General that the Department take over the work of building improved roads at Mount Gretna, in preparation for the mobilization of the cavalry, artillery and heavy supply trains. Three hundred laborers were assembled and housed in tents erected according to military regulations. These men were fed by the National Commissary Department.

Preparing Subgrade for Slag Base.

The equipment on the work included 12 traction engines, 10 rollers, 13 scrapers, 31 dump wagons, 22 auto trucks, 7 rooter plows, 9 sprinklers, 1 scarifier, 4 harrows, 4 drag scoops and 1 gasoline pump. Twenty carloads of material arrived at the scene of work daily.

Delay at the commencement of operations in securing the required quantity of slag, resulted in the State Highway Department practically commandeering a slag pile at Lebanon and department men were put to work loading cars. Former efforts to blast the crust of the slag with dynamite were abandoned, as the dynamite spread its force through the loose slag underneath the crust. The Department put in a well-drilling outfit and, after drilling holes through the hardened crust and the loosened slag, succesfully broke up the mass with black powder.

The highway work embodied principally the complete opening up of new right-of-way, which required that various operations had to be carried on in order. The section was first brushed and trees removed and stumps and rocks blasted out. The actual grading work was then taken up. Upon some of the sections this work was of magnitude and required a large organization to accomplish satisfactory results. When the right-of-way had been cleared, traction engines, with rooter plows, were started in to completely loosen up the surface. This was followed by traction engines and road machines, or graders, which completed the removal of the necessary material to the grade lines.

Loosening Up Roadbed with Rooter Plow Hauled by Traction Engine.

All craters left by the removal of stumps and large rocks were filled with stone in order to ensure a solid subgrade. Drains and culverts then were placed at the proper locations and after this the large power rollers were put in operation and the surface was thoroughly compacted. Upon the sub-base, after being properly prepared, the slag, which was being used for the base construction, was deposited in the center of the road in continuous stretches. This material was spread in two layers by machines, drawn by trac-

Spreading Surface Stone with Road Grader and Traction Engine.

tion engines, each layer being thoroughly rolled, and upon completion being about 8-in. in depth.

With the final rolling of the base, the surface of the slag was sprinkled, which tended to solidify or cement the material more uniformly. Upon this surface was deposited, in continuous piles along the center of the road, the same as was done with the slag, trap rock ballast. This also was spread in place with the use of traction engines and road machines, to a depth of about 5 in.

When the proper amount of material was secured and the spreading completed, a spiked-tooth harrow, weighing about 400 lb., was drawn over the surface of the road, back and forth, thus segregating the stone and eliminating the possibility of loose pockets. This operation was continued until the teeth of the harrow practically rode on the upper surface of the stone. Stone screenings then were spread lightly from piles at the sides and followed by sprinkling and rolling alternately, adding the necessary amount of screenings during the operation, in order to bond up the ballast stone thoroughly. This course was 4 in. in depth when compacted. The rolling and sprinkling were continued until a surface mortar was produced and the road showed no wave under the operation of the roller. When this was completed, the surface then was opened to traffic for a few days and thereafter given an additional rolling and finishing, in order to compact uniformly and completely all portions of the surface.

Upon the finished road surface, after the fine material has been swept off, a bituminous treatment of 0.4 gal. to the square yard was applied with motor pressure distributor, using Department Class "C" specification material, and covered with trap rock chips in quantities ranging from 15 to 20 lb. to the square yard, applied with mechanical spreaders.

The work was carried out under the direct supervision of George H. Biles, Second Deputy State Highway Commissioner.

Exact Weights of Vehicles Recorded in Traffic Census

What is probably the most accurate traffic census ever undertaken in this country is now being conducted by the Experimental Station of the Engineering Department of Iowa State College with the cooperation of the Iowa State Highway Commission.

The purpose of the census is to secure accurate data upon the number of vehicles using the roads, the relative proportions of travel between farm market traffic, traffic between towns classed as interurban traffic and tourist traffic, the relation between motor vehicles and team traffic, the character of the tires in use and the actual tonnage transported over the roads.

The traffic takers are equipped with a set of farm scales capable of handling any ordinary load transported over the public highways. The scales are set so that they occupy about one-half of the roadway. When a driver approaches, he is signalled to stop, and requested to drive on the scales. The outfit is weighed, and the weight, character and width of the tires, nature of the journey, whether farm traffic, interurban or tourist and other data recorded in specially prepared blanks.

The census will continue for three months. Important roads in a number of different sections of the state will be used for the tests, each of which will occupy about 10 days.

Berkeley, Cal., Zone Ordinance

Two of the greatest city planning achievements of the past year, according to the Municipal Year Book, are the New York Zone Ordinance, and the Berkeley, Cal., Zone Ordinance. A description of the last mentioned ordinance and the results obtained from it was given by Mr. Charles Henry Cheney, Architect and Consultant in City Planning, San Francisco, in a paper presented at the 9th National Conference on City Planning. An abstract of the paper follows:

Berkeley, which is a residential suburban city of 50,000 in a metropolitan area of a million people about San Francisco, is also the seat of the University of California. It corresponds somewhat in setting to Montclair, N. J., and the other suburban towns 40 minutes from New York, though it is more densely built up.

In Berkeley 90 per cent of the city is made up of detached single family residences. If we chose an ordinance districting the whole city at once, as in Los Angeles or New York, we foresaw that we should have to make it very general, like those ordinances, as the public in a short time could only be educated that far, and would be likely to misunderstand stiffer regulations or protections.

We found Minneapolis attempting the protection of single family residence districts, also our seeming greatest need, yet using the optional method of waiting until a petition from the property owners affected was filed before establishing any portion of the city under the zone ordinance.

We therefore decided that the ultimate segregation of single family residence districts, although a new departure, must be the thing to finally work toward, and we adapted an amplification of the Minneapolis method as the most desirable means of educating the public to our final necessities.

We believe that our ordinance as passed has successfully done this. It provides twenty-seven classes of districts; we shall probably never have to use all these classes, but the machinery is there if we need it. Some districts we may establish in Classes XVI and X (which latter also includes Classes I, II, III, IV and V), thus permitting both wholesale and retail business, where in an outlying residence neighborhood we would only establish small retail business centers of Class X.

There are two particularly distinctive features of this Berkeley zone ordinance: First, that it provides for single family residence districts, two family, group house, and apartment house residence districts, each protected from the other and from business and industry. The second feature that is important is that new residences are prohibited in industrial districts. We had seen many examples of industries hampered and held back by small residences and tenements.

Some manufacturers said to us, "Why, if the city keeps factories out of residence districts, should not residences be kept out of factory districts? We find in most cities the most abject poverty and the worst tenement and bad housing conditions in the factory neighborhoods. When we want heavy traffic pavement for heavy hauling with spur tracks in the sidewalk areas, these owners of deteriorated homes appear before the City Council and holler so loud that the improvements are held up. So we have dejected housing and hampered industry."

We therefore provided in Berkeley that no new residences might go into factory districts and this has not yet been under attack.

This provision further has the effect of concentrating the industrial areas, and to limit, or rather discourage, the general tendency on the part of speculators to exaggerate their size, scattering the industrial district over much more area than it can probably ever occupy to its best advantage.

During the past year, since the Berkeley Zone Ordinance went into effect, the City Council has received eight petitions for the establishment of districts under the ordinance, which have been referred to the Civic Art Commission for recommendation. These petitions were carefully checked up with a card system by the consultant to the commission, an investigator visiting each building in the proposed district, noting the use, height of building, assessed valuation, attitude of the owner, etc.

District No. 1, petitioned to be established as a Class I single family residence district, comprising nearly a square mile of the best residence section of Berkeley, where the original building restrictions imposed by the real estate tract developers had recently expired. The survey showed:

275 parcels of land, averaging 50 feet front, containing
203 single-family residences;
4 two-flat buildings;
2 converted apartment houses;
1 private school;
60 vacant lots;
Ninety per cent of houses occupied by owners;
$1,250,000 estimated value of land and improvements.

On the basis of this survey we recommended that the petition be granted, giving exact reasons why this should be maintained as a district for single family residences only.

The Commission then called a hearing of all the property owners in the proposed district, at which only a few objectors appeared. In order to make the operation of the ordinance uniform within the district, while not driving out the existing flats, converted apartment houses and school, we resorted to what is called our "reversionary clause," stating that these existing misfits could stay there as long as they were not burned or moved, or altered, but that as soon as they attempted to make a change the property would have to be used for a single family residence only, reverting to the same use as the surrounding district. This protected the people who had built the school, the flats and the apartment houses in good faith, and yet gave them reasonable time and notice to get out eventually.

The New York ordinance has a similar reversionary clause, providing the alteration is more than 50 per cent of the value of the building. We believe that this may leave the way open for a great deal of trouble in New York.

This district was then recommended by the Civic Art Commission to the Council for establishment, and the Council so acted in July, 1916, nearly a year ago, and we have had but one complaint against it since, and that from an owner of a converted apartment house, who desires to tear down and build a new building, against the protest of all of his neighbors. So far we have steadfastly refused to countenance this.

District Petition No. 2 asked that a district of Class V for apartments and all types of flats and dwellings be created over about three blocks of an old section, rather gone to seed, near the heart of the city. Our survey showed:

40 single-family residences;
12 two-family residences;
2 converted apartment buildings;
2 Japanese laundries and residences;
1 Chinese laundry;
1 construction camp and stable with 6 horses, cow, etc. No buildings in the district over two stories in height.
80 per cent of the district occupied by renters.
10 per cent of lots vacant.
$300,000 approximate value of district.

In analyzing the reasons why this district had deteriorated we found that practically all of its troubles traced back directly to the old construction camp and stable. Fumes and odors from it made the three adjoining houses to the windward impossible to rent to any but Japanese tenants, who demanded no repairs and operated laundries in these houses. There was also one Chinese laundry on the next street, which made adjoining property a block away undesirable, with consequent lowering of rents. We therefore recommended to the Council that the construction camp and laundries must be entirely eliminated, and further that the petition be granted permitting flats and apartments, provided they were not more than 2½ stories in height, as per our Class IX of the ordinance.

District Petition No. 3 asked for the classification of about one square mile of the best residence area of the city adjoining the University of California as a single family residence district of Class I. The survey showed:

294 single-family dwellings;
9 two-family dwellings;
3 group dwellings;
10 boarding clubs or fraternity houses;
1 private school;
1 creamery;
1 sanatorium.
2 large barns with 5 horses each.
$3,000,000 approximate value of district and improvements.
254 lots built upon and 131 lots vacant.

Although there were 150 petitioners for this district, strong opposition developed from a small coterie of selfish land owners, who desired to improve their property at the expense of their neighbors, regardless of the result, and who inflamed public opinion in the district as to constitutionality and every other objection possible to the ordinance. Over twenty-six neighborhood meetings have been held in this district, and two hearings by the Commission, but as yet no complete agreement has been arrived at.

District Petition No. 4. About three square blocks of high class residence district applied by classification under Class II, which permits flats. A survey showed that there was not one flat building, and only single family residences in the district as proposed. The petitioners were recommended to submit a new petition for a district of Class I, rather than to encourage the building of flats in their neighborhood. The Commission felt that whatever classification is once established, the district may be expected eventually to build up to.

District Petition No. 5, for the protection of a new church in a residence district, granted after several stormy meetings.

District Petiton No. 6, asking for the establishment of 1½ square miles of high-class residence district, as a district of Class I, for single family residences only; three-fourths of which was already under private restrictions for single family residences, and the balance of it permitted business and flats. The survey showed that no business or flats had ever been built, except upon five lots out of two hundred or more thrown open to these uses; that the whole neighborhood was practically a single family owners district, which desired to maintain its home character.

The petition was recommended to the Council to be granted, with the addition of several adjoining blocks, and will be established this month.

District Petiton No. 7. A new manufacturing plant expecting to invest a large sum of money on buildings covering about two acres of ground, was afraid to proceed on account of the existence of the zone ordinance, and until the property has been classified as an exclusive manufacturing district. The petition was recommended to the Council and the district established by ordinance.

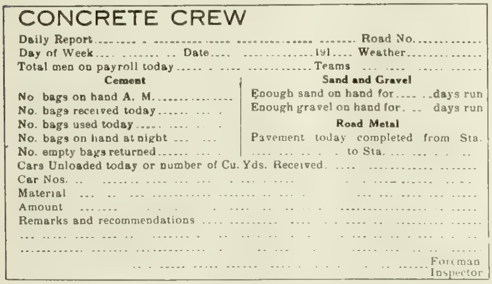
District Petition No. 8. A residence district of about three blocks became alarmed over the possible location of a negro dance hall, on a prominent corner, and petitioned for establishments as a district of Class V, permitting apartments, flats and all kinds of residences. Survey of this district showed that only single family residences and flats existed at present, with 90 per cent of the lots built upon. The petitioners were recommended to bring in a new petition for a district of Class II, permitting single family residences and flats only, which they immediately did, and the Council has just passed an ordinance establishing the district. (May, 1917.)

The above examples serve to show practical laboratory work in city planning which we have been doing in Berkeley, and how zoning for single family residences is not only essential, but in demand and ready to be fought for by the people themselves. Every city in the country, we feel, has got to come to it sooner or later, and we believe that by being careful, ironing out the misunderstandings, and treating everybody fairly, without too much pressure on existing misfits and intrusions, that we can firmly establish this great principle of protecting the home against the intrusion of the less desirable and floating renter class.

However, we warn other cities to be most careful about establishing single family residence districts. No city should do so unless it is prepared to spend whatever is necessary for adequate legal advice to carry the matter to the United States Supreme Court if necessary.

Report Forms for Inspectors of Milwaukee County Highway Department

Practically all construction work for the Highway Department of Milwaukee County, Wisconsin, is carried on by contract. The inspection is taken care of by an inspector with each crew, except grading crews, and occasionally a culvert crew, and also by the superintendent of construction, who superintends all of the construction work and acts as chief inspector, visiting each job as often as possible and checking up the work to see if the inspector is getting the desired results.



CONCRETE CREW

Daily Report .... Road No. ....
Day of Week .... Date .... 191 .... Weather ....
Total men on payroll today .... Teams ....

Cement
No bags on hand A. M. ....
No. bags received today ....
No. bags used today ....
No. bags on hand at night ....
No. empty bags returned ....

Sand and Gravel
Enough sand on hand for .... days run
Enough gravel on hand for .... days run

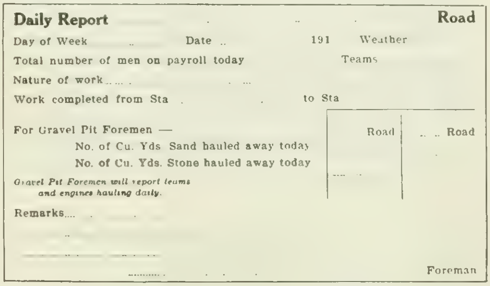
Road Metal
Pavement today completed from Sta. .... to Sta. ....

Cars Unloaded today or number of Cu. Yds. Received ....
Car Nos. ....
Material ....
Amount ....
Remarks and recommendations ....

.... Foreman
Inspector

Fig. 1—Inspectors' Daily Report Form for Concrete Roads and Culverts.

The inspector is given a copy of the plans and specifications and is expected to see that they are carried out in every detail. He is also required to file a daily report on the form shown as Fig. 1 for concrete roads and culverts, and on the form shown as Fig. 2 for earthwork, these reports being checked up in the office by the commissioner and the superintendent, and if the material used does not balance with the amount of road constructed, or if the proper portions have not been used, the superintendent immediately visits the work and takes steps to see that the fault is corrected.



Daily Report Road
Day of Week Date 191 Weather
Total number of men on payroll today Teams
Nature of work
Work completed from Sta to Sta

For Gravel Pit Foremen — Road .. .. Road
No. of Cu. Yds Sand hauled away today
No. of Cu. Yds. Stone hauled away today

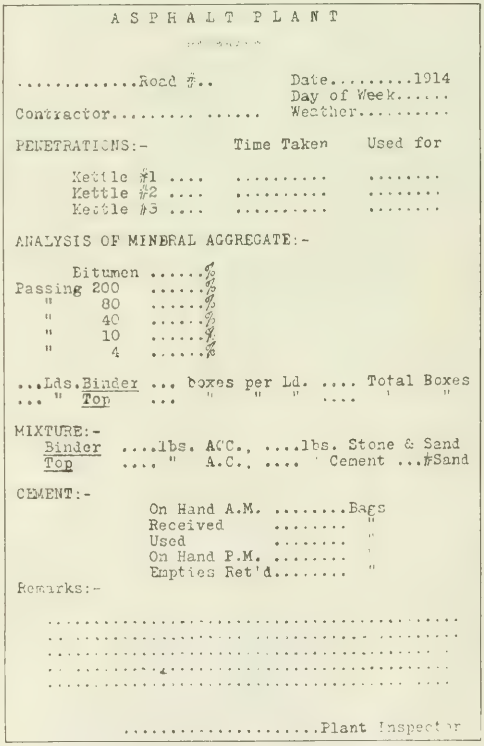
Gravel Pit Foremen will report teams and engines hauling daily.

Remarks

Foreman

Fig. 2—Inspectors' Daily Report Form for Earthwork.

On sheet asphalt pavement construction the county maintains an inspector on the work and one at the plant. The plant inspection consists in watching the weights and temperatures of the sand, stone and asphaltic cement and the penetration of the asphaltic cement, and of analyzing the surface mixtures daily. The form used for the daily report of the asphalt plant inspector is shown as Fig. 3.



ASPHALT PLANT

..........Road #.. Date..........1914
Day of Week......
Contractor.......... Weather..........

PENETRATIONS:-	Time Taken	Used for
Kettle #1	....	....
Kettle #2	....	....
Kettle #3	....	....

ANALYSIS OF MINERAL AGGREGATE:-

Bitumen ......%
Passing 200 ......%
" 80 ......%
" 40 ......%
" 10 ......%
" 4 ......%

...Lds.Binder ... boxes per Ld. .... Total Boxes
... " Top ... " " " .... " "

MIXTURE:-
Binder ....lbs. ACC., ...lbs. Stone & Sand
Top .... " A.C., ... " Cement ...#Sand

CEMENT:-
On Hand A.M. ....Bags
Received .... "
Used .... "
On Hand P.M. .... "
Empties Ret'd........ "

Remarks:-

....................Plant Inspector

Fig. 3—Form of Daily Report by Inspectors at Asphalt Plant.

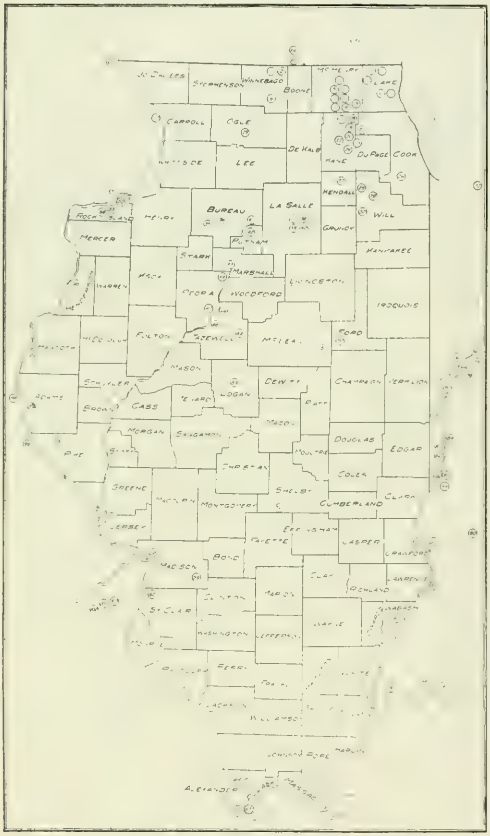
Conmercial Deposits of Road Materials in Illinois

The lack of local materials suitable for road construction in many parts of Illinois makes the knowledge of commercial deposits a matter of special importance to all concerned in highway construction. Gravel pits and stone quarries are scarce in the central, eastern and southern portions of the state, and materials used in building hard surfaces on highways have to be shipped in, often from considerable distances. As these materials are very heavy and their transportation is expensive, it is desirable to have information of the deposits of material that are most readily available and at lowest cost. Owing to wide variations in freight rates and often prohibitive switching rates, it is sometimes possible to obtain materials which have to be transported long distances by rail cheaper than materials from quarries or pits that are located within a few miles of the work.

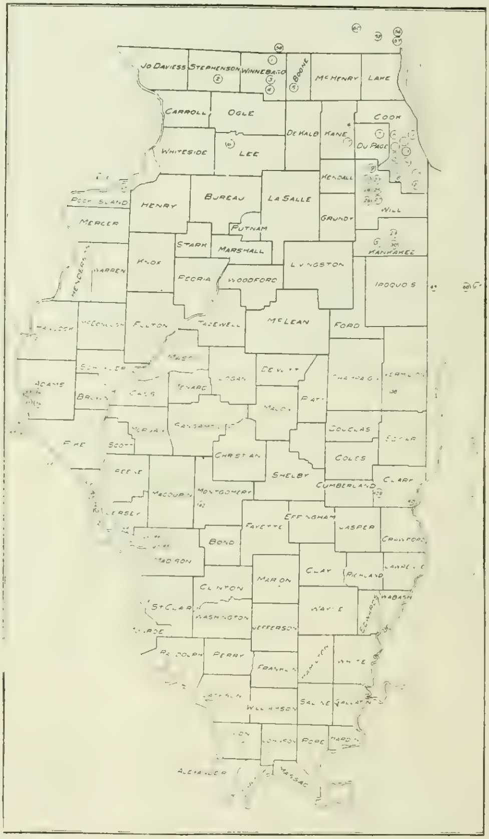
A useful compilation of statistics on the materials available for highway construction has been issued recently by the Illinois State Highway Department. This bulletin was prepared by Mr. F. L. Roman, Testing Engineer of the Department, and it gives in readily available form information regarding the commercial deposits that have been brought to the attention of the State Highway Department during past years.

The accompanying maps, reproduced from the bulletin, show the approximate locations of the sand and gravel deposits and the stone quarries. Each deposit is numbered, and reference to the tables following, also abstracted from the bulletin, will show the capacities of the plants and the names of the owners. The pits are numbered from north to south, first in Illinois, following with the neighboring states. Only those deposits from which road materials have been shipped to Illinois in the past have been listed.

The maps are intended to show only the approximate location of the deposits. To determine the shipping facilities from or to any given point, reference should be made to some large railroad map.



Map Showing Location of Sand and Gravel Deposit.



Map Showing Location of Stone Quarries.

SAND AND GRAVEL PRODUCERS.

No.	Capacity.	Owner.
1	1,500 yd.	Great Western Sand & Gravel Co., Chicago.
2	1,800 yd.	Atwood-Davis Sand Co., Chicago.
3	13 cars	American Sand & Gravel Co., Chicago.
4	12-15 cars	James A. Buckley, Chicago.
5	25 cars	The Consumers' Co., Chicago.
6	12 cars	American Sand & Gravel Co., Chicago.
7	600 yd.	Lake County Gravel Co., Chicago.
8	30 cars	American Sand & Gravel Co., Chicago.
9	20 cars	Consumers' Co., Chicago.
10	75 cars	Lake Shore Sand Co., Chicago.
11	....	Aetna Sand & Gravel Co., Algonquin, Ill.
12	....	Pyatt Gravel & Sand Co., Algonquin, Ill.

No.	Capacity.	Owner.
13	....	Reinert Brothers, Algonquin, Ill.
14	....	Ready-Ryan Sand & Gravel Co., Algonquin, Ill.
15	15 cars	American Sand & Gravel Co., Chicago.
16	40 cars	Rockford Sand & Gravel Co., Rockford, Ill.
17	20 cars	American Sand & Gravel Co., Chicago.
18	35 cars	Richardson Sand & Gravel Co., Chicago.
19	50 cars	A. Y. Reed Gravel Co., Elgin, Ill.
20	....	Chicago Gravel Co., Chicago.
21	20 cars	American Sand & Gravel Co., Chicago.
22	....	Esson Sand & Gravel Co., Chicago.
23	50 cars	Richardson Sand & Gravel Co., Chicago.
24	1,000 yd.	Great Western Sand & Gravel Co., Chicago.
25	5 cars	Oregon Gravel Co., Oregon, Ill.
26	400 yd.	Worth Sand & Gravel Co., Worth, Ill.
27	15 cars	H. D. Conkey Sand & Gravel Co., Mendota, Ill.
28	....	Chicago Gravel Co., Chicago.
29	....	Chicago Gravel Co., Chicago.
30	1,000 yd.	Illinois Gravel & Material Co., Joliet, Ill.
31	300 yd.	Moline Sand Co., Moline, Ill.
32	400 yd.	Rock Island Sand & Gravel Co., Rock Island, Ill.
33	600-800 yd.	Interstate Material Co., Davenport, Ia.
34	1,000 yd.	McCraney Sand & Gravel Co., Davenport, Ia.
35	400 yd.	Galesburg Sand & Gravel Co., Galesburg, Ill.
36	....	F. G. Boyden, Sheffield, Ill.
37	500 yd.	Moline Sand & Gravel Co., Moline, Ill.
38	10 cars	Illinois Valley Sand Co., Ottawa, Ill.
39	200 yd.	C. S. Ayers, Ottawa, Ill.
40	100 yd.	Ottawa Silica Co., Ottawa, Ill.
41	600 yd.	Western Sand & Gravel Co., Spring Valley, Ill.
42	15 cars	H. D. Conkey Sand & Gravel Co., Mendota, Ill.
43	80 yd.	South Lacon Sand & Gravel Co., Lacon, Ill.
44	1,200 yd.	Mackinaw Sand & Gravel Co., Lincoln, Ill.
45	[illegible] cars	Terry & Lewis, Galesburg, Ill.
46	800 yd.	Peoria Washed Sand & Gravel Co., Peoria, Ill.
47	100 yd.	J. H. Gerrard, Peoria, Ill.
48	80 cars	Virginia Timber Co., Springfield.
49	600 yd.	Mackinaw Sand & Gravel Co., Lincoln, Ill.
50	14 cars	Gibson Sand & Gravel Co., Gibson City, Ill.
51	....	W. S. Youle, Saybrook, Ill.
52	40 cars	Hamilton Stone & Sand Co., Hamilton, Ill.
53	50 cars	Lincoln Sand & Gravel Co., Lincoln, Ill.
54	10 cars	Quincy Sand Co., Quincy, Ill.
55	20 cars	Barry Sand & Gravel Co., Barry, Ill.
56	*.........	
57	40 cars	Neal Gravel Co., Mattoon, Ill.
58	1,500 yd.	Mississippi Sand Co., Alton, Ill.
59	150 yd.	Stocker Gravel & Artificial Stone Co., Highland, Ill.
60	2,000 yd.	Union Sand & Material Co., St. Louis, Mo.
61	150-250 yd.	Mt. Carmel Sand & Gravel Co., Mt. Carmel, Ill.
62	300 yd.	Mt. Carmel Elevator Co., Mt. Carmel, Ill.
63	20 cars	Yourtee-Roberts Sand Co., Chester, Ill.
64	1,200 yd.	Novaculite Paving Co., St. Louis, Mo.
65	20 cars	H. H. Halliday Sand Co., Cairo, Ill.

Wisconsin.

No.	Capacity.	Owner.
66	105 cars	Janesville Sand & Gravel Co., Janesville, Wis.
67	....	Great Western Sand & Gravel Co., Chicago, Ill.
68	3,000 yd.	Waukesha Lime & Stone Co., Waukesha, Wis.

Iowa.

No.	Capacity.	Owner.
69	....	Molo Sand & Gravel Co., Dubuque, Ia.
70	12 cars	Sabula Sand & Gravel Co., Sabula, Ia.
71	....	Interstate Material Co., Davenport, Ia.

Indiana.

No.	Capacity.	Owner.
72	35 cars	Consumers' Co., Chicago, Ill.
73	20 cars	Million Brothers, Lake Cicott, Ind.
74	35 cars	Lewisburg Stone Co., West Lafayette, Ind.
75	15 cars	Lafayette Hydraulic Co., Lafayette, Ind.
76	35 cars	Kickapoo Sand & Gravel Co., Attica, Ind.
77	35 cars	Indiana Sand & Gravel Co., Chicago, Ill.
78	30 cars	Carmichael Gravel Co., Williamsport, Ind.
79	15 cars	The Neal Gravel Co., Mattoon, Ill.
80	25 cars	The Neal Gravel Co., Mattoon, Ill.
81	800 yd.	Interstate Sand & Gravel Co., Terre Haute, Ind
82	20 cars	The Neal Gravel Co., Mattoon, Ill.
83	4-5 cars	Clover Leaf Gravel Co., Cayuga, Ind.
84	25 cars	Wabash Sand & Gravel Co., Terre Haute, Ind
85	35 cars	Summit Sand & Gravel Co., Terre Haute, Ind.
86	1,000 yd.	A. Miller & Sons, Clinton, Ind.
87	30 cars	Summit Sand & Gravel Co., Terre Haute, Ind
88	28 cars	Wabash Sand & Gravel Co., Terre Haute, Ind.
89	500 yd.	Macksville Gravel Co., Terre Haute, Ind.
90	20 cars	East & De Frees, Worthington, Ind.
91	800-1,200 yd.	Merom Gravel Co., Indianapolis, Ind.
92	800 tons	Anderson-Theobald Co., Vincennes, Ind.
93	500 yd.	P. W. Lebanon & Sons, Vincennes, Ind.
94	20 cars	Bedford Nuget Co., Evansville, Ind.
95	400-500 yd.	Independent Sand & Gravel Co., Evansville, Ind.
96	750 yd.	Evansville Sand & Gravel Co., Evansville, Ind
97	500 yd.	Evansville Sand & Gravel Co., Evansville, Ind.

Missouri.

No.	Capacity.	Owner.
98	....	Canton Sand Co., Canton, Mo.
99	400 yd.	Geo. W. Camery, Hannibal, Mo.
100	1,800 yd.	Union Sand & Material Co., St. Louis, Mo.
101	....	Universal Sand Co., St. Louis, Mo.
102	25 cars	Continental Portland Cement Co., St. Louis, Mo.

CRUSHED STONE PRODUCERS.

No.	Capacity.	Owner.
1	....	G. W. Martin, 533 Fisher Ave., Rockford, Ill.
2	125 yd.	Sanford & Zartman, Freeport, Ill.
3	....	Carrico Stone Co., Rockford, Ill.
4	200 yd.	Hart & Page, Rockford, Ill.
5	150 yd.	Electric Stone Co., Belvidere, Ill.
6	....	W. H. Rink, Dixon, Ill.
7	1,000-1,500 yd.	Elmhurst-Chicago Stone Co., Elmhurst, Ill.
8	2,500 yd.	A. C. O'Laughlin Co., Chicago.
9	600 yd.	Chicago Union Lime Works Co., Chicago.
10	....	Dolese & Shepard Co., Chicago.
11	....	Riverside Lime & Stone Co., Chicago.
12	1,000 yd.	Superior Stone Co., Chicago.
13	1,000 yd.	Chicago Union Lime Works Co., Chicago.
14	5,000 yd.	U. S. Crushed Stone Co., Chicago.
15	6,000 yd.	Dolese & Shepard Co., Chicago.
16	....	Elgin Crushed Stone & Sand Co., Elgin, Ill.
17	....	John Hendrickson, Batavia, Ill.
18	2,000 yd.	Illinois Stone Co., Chicago.
19	15-20 cars	Joliet Crushed Stone Co., Joliet, Ill.
20	300 yd.	Franklin Stone Co., Blue Island, Ill.
21	5,000 yd.	Brownell Improvement Co., Chicago.
22	1,000 yd.	Contracting & Material Co., Chicago.
23	700 yd.	Ideal Crushed Stone Co., Joliet, Ill.
24	200 yd.	Joliet Artificial Stone Co., Joliet, Ill.
25	2,500 yd.	National Stone Co., Joliet, Ill.
26	12 cars	State Penitentiary, Joliet, Ill.
27	1,500 yd.	Western Stone Co., Joliet, Ill.
28	150 yd.	T. B. & S. S. Davis, Rock Island, Ill.
29	500 yd.	McLaughlin-Cook Co., Kankakee, Ill.
30	....	West Side Quarry, Kankakee, Ill.
31	1,500 yd.	Lehigh Stone Co., Kankakee, Ill.
32	10 cars	Hamilton Stone & Sand Co., Hamilton, Ill.
33	200 yd.	Marblehead Lime Co., Chicago.
34	200 yd.	William D. Meyer, Quincy, Ill.
35	80-120 yd.	F. W. Menke Stone & Lime Co., Quincy, Ill.
36	....	Roeder-Greenmann Stone & Construction Co., Quincy, Ill.
37	100 yd.	Marblehead Lime Co., Chicago.
38	....	Casparis Stone Co., Columbus, O.
39	....	Casey Stone Co., Casey, Ill.
40	150 yd.	Farmers Limestone Milling Co., Robinson, Ill.
41	200 yd.	John Brogan, Eldred, Ill.
42	400 yd.	M. T. Kiggins, Hillsboro, Ill.
43	200 yd.	Grafton Quarry Co., St. Louis, Mo.
44	100 yd.	Western Whiting Mfg. Co., Elsah, Ill.
45	200 yd.	Harry Gissal Quarry Co., Alton, Ill.
46	400 yd.	Mississippi Sand Co., Alton, Ill.
47	200 yd.	Reliance Quarry & Construction Co., Alton, Ill.
48	70 yd.	C. F. Yeakel, Alton, Ill.
49	400 yd.	East St. Louis Stone Co., East St. Louis, Ill.
50	700 yd.	Casper Stolle Quarry & Contracting Co., East St. Louis, Ill.
51	200 yd.	Columbia Quarry Co., St. Louis, Mo.
52	....	Columbia Quarry Co., St. Louis, Mo.
53	2 cars	State Penitentiary, Chester, Ill.
54	400 yd.	C. F. Massey Co., Chicago.
55	800 yd.	Charles Stone Co., Marion, Ill.

Wisconsin.

No.	Capacity.	Owner.
56	2,000 yd.	Universal Crushed Stone Co., Chicago.
57	....	U. S. Crushed Stone Co., Chicago.
58	1,500 yd.	Wisconsin Granite Co., Chicago.
59	800 yd.	Racine Stone Co., Chicago.
60	1,000 yd.	Waukesha Lime & Stone Co., Waukesha, Wis.

Iowa.

No.	Capacity.	Owner.
61	400 yd.	Linwood Quarries Co., Davenport, Ia.
62	1,000 yd.	Dolese Bros. Co., Chicago.

Missouri.

No.	Capacity.	Owner.
63	200 yd	Hannibal Lime Co., Hannibal, Mo.
64	100 yd.	Hannibal Lime Co., Hannibal, Mo.
65	75 yd	Hueston-Bland Stone Co., Hannibal, Mo.
66	200 yd	Marblehead Lime Co., Chicago.

Indiana.

No.	Capacity.	Owner.
67	1,200 yd.	Ohio & Western Lime Co., Huntington, Ind.
68	3,500 yd.	Casparis Stone Co., Columbus, O.
69	....	Newton County Stone Co., Kentland, Ind.
70	800 yd.	A. & C. Stone & Lime Co., Indianapolis, Ind.
71	30-40 cars	Ohio & Indiana Stone Co., Indianapolis, Ind.
72	1,000 yd.	Spencer Stone Co., Indianapolis, Ind.
73	500 yd.	Mitchell Lime Co., Mitchell, Ind.

*Pit may be opened in a short time.

Proposed Toughness Test for Road Rock

A revision of the present test for toughness of macadam rock was recommended at the last annual meeting of the American Society for Testing Materials by the Society Committee on Road Materials. The present test was made standard by the Society in 1908. The revised form gives more complete and specific directions and at the same time makes the test more serviceable for ascertaining the relative toughness of different rocks. The committee recommended that the test be published as tentative for one year before referring it to letter ballot of the Society for adoption as standard. The proposed test follows:

1. Toughness, as applied to rock, is the resistance offered to fracture under impact, expressed as the final height of blow required of a standard hammer to cause fracture of a cylindrical test specimen of given dimensions.

2. Quarry samples of rock from which test specimens are to be prepared shall measure at least 6 in. on a side and at least 4 in. in thickness, and when possible shall have the plane of structural weakness[1] of the rock plainly marked thereon. Samples should be taken from freshly quarried material, and only from pieces which show no evidences of incipient fracture due to blasting or other causes. The samples should preferably be split from large pieces by the use of plugs and feathers and not by sledging. Commercial stone-block samples from which test specimens are to be prepared shall measure at least 3 in. on each edge.

3. Specimens for test shall be cylinders prepared as described in Section 4, 25 mm. in height and 24 to 25 mm. in diameter. Three test specimens shall constitute a test set. The ends of the specimen shall be plane surfaces at right angles to the axis of the cylinder.

4. One set of specimens shall be drilled perpendicular and another parallel to the plane of structural weakness of the rock, if such plane is apparent. If a plane of structural weakness is not apparent one set of specimens shall be drilled at random. Specimens shall be drilled in a manner which will not subject the material to undue stresses and which will insure the specified dimensions.[2] The ends of the cylinders may be sawed by means of a band or diamond saw,[3] or in any other way which will not induce incipient fracture, but shall not be chipped or broken off with a hammer. After sawing, the ends of the specimens shall be ground plane with carborundum or emery on a cast-iron lap until the cylinders are 24 mm. in length.

5. Any form of impact machine which will comply with the following essentials may be used in making the test:

(a) A cast-iron anvil weighing not less than 50 kg., firmly fixed upon a solid foundation.

(b) A hammer weighing 2 kg., arranged so as to fall freely between suitable guides.

(c) A plunger made of hardened steel and weighing 1 kg., arranged to slide freely in vertical direction in a sleeve, the lower end of the plunger being spherical in shape with a radius of 1 cm.

(d) Means for raising the hammer and for dropping it upon the plunger from any specified height from 1 to not less than 75 cm., and means for determining the height of fall to approximately 1 mm.

(e) Means for holding the cylindrical test specimen securely on the anvil without rigid lateral support, and under the plunger in such a way that the center of its upper surface shall, throughout the test, be tangent to the spherical end of the plunger at its lowest point.

6. The test shall consist of a 1-cm. fall of the hammer for the first blow, a 2-cm. fall for the second blow, and an increase of 1-cm. fall for each succeeding blow until failure of the test specimen occurs.

7. The height of the blow in centimeters at failure shall be the toughness of the test specimen. The individual and the average toughness of three test specimens shall be reported when no plane of structural weakness is apparent. In cases where a plane of structural weakness is apparent the individual and average toughness of the three specimens in each set shall be reported and identified. Any peculiar condition of a test specimen which might affect the result, such as the presence of seams, fissures, etc., shall be noted and recorded with the test result.

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[1] The plane of structural weakness may in certain cases be the rift, cleavage or bedding plane.

[2] The form of diamond drill described in Bulletin No. 347, U. S. Department of Agriculture, pp. 6-7, is recommended, and should prove satisfactory if the instructions are strictly followed.

[3] A satisfactory form of diamond saw is described in Bulletin No. 347, U. S. Department of Agriculture, pp. 7-9.

Methods of Handling and Measureing Bulk Cement

There is no argument needed to convince the contractor and engineer that the elimination of the package problem in connection with portland cement would result in economy and saving. The question which is uppermost in the minds of superintendents on the job is how to handle and measure bulk cement from the time it arrives in railroad cars until it finds its way into the charging hopper of the mixer.

There are several methods which have been successfully used, the choice of which depends upon the size of the job, railroad facilities and the general layout of the construction plant.

To those who have not used cement in bulk it may seem reasonable to suppose that it will be exceedingly dusty to handle. Experience has proved the contrary. Bulk cement in transit becomes packed so that on its arrival at destination, a man can walk on the surface without sinking in to any appreciable depth. This packing makes it possible to shovel the cement with practically no amount of dust being raised. There are no sacks to be shaken and that is perhaps the most dusty operation in the handling of cement for construction work.

On work where cement is being used in quantities of half a car per day or more, and where the mixing plant is located within reasonable distance of the receiving siding, the simplest method of handling bulk cement is to shovel it directly from the car into wheelbarrows of known capacity and then through the provision of proper runways, wheel the cement directly to the charging hopper of the mixer. Measurement, when this method of unloading and handling is used, can be effected in the same way that the measurement of coarse and fine aggregate is done. This method is applicable more properly to work of not very great size and where construction operations will cover only a comparatively short length of time.

Where railroad facilities and the size of the work warrant it, it is advisable to provide storage for cement. This may be made more advisable on account of car shortage or the liability of irregular shipment. The most commonly followed method where storage is provided is to unload the car of bulk cement by means of a power shovel. Shovels of the type used in handling grain can be used, but it has been found more practical and efficient to use a shovel of a scoop type, having sides and back so that the load first taken is retained. The flat shovel allows the cement to flow off either side and over the top and for this reason is less desirable. The shovel should be attached by cable to a motor or engine of from 7 to 10 horsepower. With this equipment 200 barrels can be unloaded from a car in three hours. The power shovel dumps the cement from the car into the boot of a bucket elevator which in turn raises it, discharging into the storage bin. This method should be followed where the floor of the storage bin is approximately on the level of or above the railroad track. If the track level is well above that of the storage, cement can be spouted from the car by gravity to storage.

On some work where the mixing plant has been located at a greater or less distance from the receiving tracks and the main cement storage, bins have been erected over the mixers for stone, sand and cement. These bins are so constructed as to hold sufficient material to insure the continuous operation of the mixing plant. Where this condition holds a belt conveyor from the main cement storage can be laid to the bins feeding the charging hoppers of the mixer. This belt conveyor can be fed by means of a screw conveyor running the length of the main cement storage.

Successful use has been made of automatic scales placed beneath the three material bins over the mixer for the accurate proportioning of mixes. The scales can be so set as to permit of any particular mix of concrete being delivered to the charging hopper.

The method above outlined, that is, the use of a power shovel and bucket elevator, is particularly applicable to the average plant manufacturing concrete products. It is evident that the construction of permanent storage facilities in such cases would be economical and efficient.

Industrial railways have been used to a considerable extent in unloading and handling bulk cement. Industrial track is laid parallel to the receiving siding and industrial cars are loaded direct from the sand, stone and bulk cement cars on the siding. In this case measuring boxes are affixed to each car of material, so arranged that one holding the proper amount of material for one batch of concrete can be dumped directly into the industrial car, which as it travels along receives all three materials in proper proportions for one batch of concrete. Industrial track leads to the mixing plant where the cars are dumped into the mixing hopper.

Bulk cement has been successfully used on work where the mixing plant was at a considerable distance from the receiving track. Tight bottomed dump wagons have been loaded directly from the car and driven to the work and the cement dumped into boxes from which it is drawn as needed. In such cases measurement is effected by the same means as employed for the coarse and fine aggregates. The point might be raised that there would be no protection from damage by water if such a scheme were followed and accordingly attention is called to the fact that cement sacks do not keep cement from getting wet, but rather tend to absorb moisture, thereby actually increasing the liability of damage to cement by water.

As has been previously mentioned, before determining the method to be employed in handling bulk cement, local conditions and facilities should be thoroughly investigated and the nature of the work given due consideration so that that scheme which is most properly adapted to the job can be used.

Change in Light Surface Treatments

During 1916 the disagreeable features, from a traffic standpoint, connected with the use of asphaltic oils for light surface treatments on New York State roads were obviated to a considerable extent by a slight change in the specifications by which the amount or texture of the asphaltic residue was not changed, but the character of the flux was to some extent regulated, in that approximately one-half of the flux was required to be a light volatile oil which would evaporate in about two days' time after being applied to the pavement.

This modification, according to the annual report of Fred W. Sarr, Second Deputy State Highway Commissioner, resulted in decreasing the length of time from one-half to three-quarters, during which the condition of the pavement after treatment was objectionable from a traffic standpoint and increased the cost of the application about $25 per mile.

Tests of Concrete Road Aggregates

Interesting conclusions on the wear and strength of concrete road surfaces were given by Mr. J. P. Nash in a paper presented at the last annual meeting of the American Society of Testing Materials. The conclusions are based on the results of tests of concrete made for the purpose of determining the resistance to abrasion and the tensile strength with various aggregates. An abstract of the paper follows:

In the tests the chief variable was the coarse aggregate. The sand used in most of the tests was a well-graded Colorado River sand, passing a ¼-in. sieve. However, where the coarse aggregate was graded to ⅛ in. a finer sand was used. The Colorado River sand is composed of rather angular fragments of flint, quartz, and a small proportion of limestone. With the exception of a slag from Birmingham, Ala., and a sample of gravel from New Orleans, all the materials used were from Texas. Similar materials may be found in most parts of the United States.

The test specimens to determine resistance to wear consisted of concrete rings, which were revolved in a standard brick rattler, the loss in weight and appearance of the surface of the specimens being the index of the wearing qualities of the aggregate. An apparatus was devised to test the concrete in tension.

The compression specimens were 6 in. in diameter and 12 in. high, made on plate glass so that a plain surface was secured on one end, the other being bedded in plaster of Paris when tested.

The tension specimens were similar in shape to the standard cement briquettes, having a section area at the center of 25 sq. in. The specimen was 5 in. deep and at the narrowest part was 5 in. wide, while the length was 12 in.

The abrasion specimens consisted of a large concrete ring 20 in. in inside diameter, 28 in. in outside diameter, and 8 in. deep. The 4-in. thickness of concrete was reinforced with two steel rods to prevent cracking from unequal stresses in the rattler.

Results of Tests.

The Gravel Aggregate.—The surface of most of the gravel concrete specimens was rough. Gravel specimens, containing pebbles of varying hardness, produced a surface in which the hard flints wore but little, while the softer limestones wore equally with the mortar. In many cases these flints protruded as much as ½ in. above the surrounding surface. Other gravels, composed of pebbles of equal hardness, were so much harder than the surrounding mortar that the latter wore much faster than the stones, causing a somewhat uniform, but extremely rough, surface. The hard stones were knocked out, causing more than normal pitting and loss in the specimen. An exception to the general run of the gravels was one composed of limestone and sandstone pebbles only, which have approximately the same hardness. In this case the pebbles themselves were but little, if any, harder than the mortar, and consequently the specimen wore surprisingly uniformly. In this particular instance, it should be noted that the gravel contained no pebbles over 1¼ in. in size, which undoubtedly influenced the satisfactory conditions of the surface.

Crushed Stone Aggregates.—Where crushed limestone was used as the coarse aggregate, the surface as a rule was smooth and uniform. The limestones tested were all comparatively soft and they wore equally with the mortar. In specimens where the aggregate contained some large stones the surface became somewhat wavy, due to the fact that the larger stones did not wear as fast as the smaller ones. In those specimens in which the aggregate was below 1½ in. in size, the surfaces were very satisfactory. In one or two of the specimens that contained some very soft stones, there was a tendency for these stones to be pitted. This, however, does not seem to be any serious disadvantage.

With the crushed trap-rock specimens the results were interesting. The stone is a basalt having high resistance to abrasion in the Deval machine, and very tough. Trap rock from the same quarry was used in all the tests. In the 1:2:4 concrete specimens, the mortar wore faster than the stone, giving the surface a distinctly mosaic appearance. This was more noticeable with the larger-sized aggregates.

In the 1:1½:3 concrete specimens, the mosaic appearance of the surface was still apparent with the larger-size aggregate; but with that graded only to 1 in. the surface was very satisfactory, having but few protruding stones. This latter specimen also had a high resistance to abrasion.

The specimen in which slag was used for the coarse aggregate had a rather high resistance to abrasion and a fairly uniform surface. It is believed that if this aggregate was limited in size to about 1¼ in. the surface would be very smooth. The surface appeared rather porous when enough of the slag fragments had been worn away to expose their interior. From this apparent porosity of the specimen, it would seem that it should make a satisfactory surface for a treatment of asphalt or tar.

Tension Tests.—From the results obtained it is apparent that no relation exists between the compressive and tensile strengths of any given concrete. When the limestone concrete fails in tension practically all of the stones are broken, but with gravel there are always quite a number of stones that are pulled out rather than broken. The number broken depends upon the smoothness of the stones, but even with the very smooth stones a good proportion of them break.

It is preferable that the tensile strength of concrete for road construction shall be obtained by using superior aggregates rather than additional cement, because the contraction due to setting of the concrete increases with the amount of cement, which tends to nullify the extra strength obtained.

Comparison of Field and Laboratory Concrete.

There is a great similarity between the results obtained in the laboratory and those shown in actual construction. A portion of San Pedro Ave. in San Antonio, Tex., was constructed about 4 years ago of a concrete composed of 1 part of cement, 2 parts of a medium fine sand, and 4 parts of a soft local limestone. This street carries a fairly heavy traffic and is in excellent condition today, being smooth and free from depressions. While this is a poorer concrete than any of those tested, the appearance of the surface is practically the same as that of the surface of the limestone specimens. The surface of this street would seem to indicate that when a soft stone is used, the mortar also should be weak so that both should wear equally.

On N. Laredo St., in the same city, a traprock concrete has been in use for something less than 2 years. The proportion of the concrete was 1:2:4, the stone being the same trap rock as that used in the laboratory tests, except that it was graded from ¼ in. to 2 in. The condition of the surface of the street, however, brings out the similarity of the wear with that of the laboratory specimens. The mortar is wearing rapidly away from the stones, leaving them protruding from the surface. The large size stone used aided this result considerably, it is believed.

Conclusions.

The conclusions drawn from these tests are as follows:

1. The uniformity of wear is obtained when the mortar and the coarse aggregate wear equally, such as when crushed limestone or limestone gravel is used.
2. The coarse aggregate should be limited in size to about 1½ in.
3. When hard, tough stone is used, the size should be limited to about 1 in. and the cement content increased.
4. It is questionable if a richer mix than a 1:2:4 is an economical one to use with crushed limestone of the ordinary hardness. Crushed slag when hard and uniform should be satisfactory as a concrete road aggregate.
5. In a 1:2:4 concrete, a gravel composed of very hard stones such a flint, or quartz, does not wear uniformly.
6. The action of the cubical shot on the test specimens is a trifle more severe than the traffic on the road.
7. It cannot be said that either the crushed stone or gravel tested is superior as an aggregate to produce concrete having a higher tensile strength.

Traffic Manager for County Highway Department

All matters pertaining to shipments and accounting of freight and cement for county road work in Milwaukee County, Wisconsin, is handled by a special official of the County Highway Department known as the traffic manager.

In addition to the handling of freight on contract jobs, the traffic manager looks after the spotting of cars for the force account work. He also keeps daily accounts of cement delivered on each job, empty bags returned, payments due cement dealers and bag credits received from cement dealers, together with the testing records for all cement used.

The county is allowed a special freight rate on all sand and gravel used in the construction of State-aid highways. Last year the difference between the special rate and the regular tariff rate amounted to $1,176. In order to obtain the special rate, it is necessary for the contractor to make application for the same to the County Highway Commissioner, giving the name of the shipper, point of origin, destination, railroad over which the material is to move, approximate tonnage and the name of the highway on which the material is to be used. The application is then sent to the State Highway Commission, who, in turn, apply to the railroad which is to haul the material. This necessitates the shipping of all material in the name of the County Highway Commissioner, who pays all freight and deducts the same from the contractor's payments.

During the past year the highway department handled 1,018 cars of sand and gravel, 3 cars of tar and 437 cars of cement, together with one car of machinery, making a total of 1,459 cars of material, of which 14 cars of sand and gravel were reconsigned and 8 cars of sand and gravel rejected.

Mechanical Means for Safeguarding Grade Crossings

In connection with its investigation of railroad grade crossings the California Railroad Commission has considered various methods of protecting the crossings by compelling slow speed by means of physical obstacles placed in the way of vehicles. Several different plans of this sort were suggested to the commission, and six of the best of them, revised to a certain extent, were sent to railroads, cities and counties for criticisms and suggestions, with the request that experimental installations be made. The six best designs are described in a recent progress report of the commission, from which this note is taken.

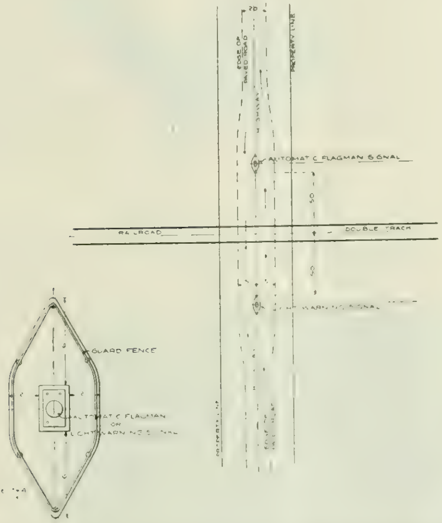


Fig. 1—Safety Grade Crossing Based on Sketch Submitted by Division Engineer, Southern Pacific Co.

The plans that met with almost universal approval are illustrated as Figs. 1 and 2. The design shown in Fig. 1 is based on a sketch submitted by the Division Engineer's Office of the Coast Division of the Southern Pacific Co. This plan forms an obstacle in the roadway so very slight that it hardly can be called an obstruction to traffic. The principal advantage is in the fact that it locates the warning signal in the position in which it can best be seen.

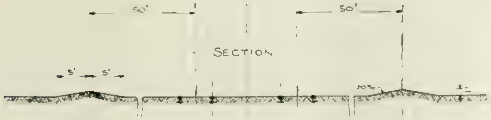


Fig. 2—Safety Device Used at Memphis, Tenn.

The plan shown in Fig. 2 is now in use in the city of Memphis, Tenn. The City Engineer reports that the installation of the device has resulted in a diminution of the number of grade crossing accidents in that city.

Probably the best type of safety crossing so far designed is a combination of the devices Figs. 1 and 2, which was suggested by City Engineer M. M. O'Shaughnessy of San Francisco. On his plan the profile of the road is slightly broken about 400 ft. from the crossing and on both sides of it; 25 ft. beyond this break, toward the crossing, an approach warning sign is located on the right-hand side of the road, looking toward the track; about 50 ft. from the crossing the flagman device and the crossing sign shown in Fig. 1 are placed in the center of the road and the road is widened to provide for the guard fence which surrounds them; immediately beyond the fence is an accentuated break in the road profile, as shown in Fig. 2.

Road Sign with Counter Sunken Letters

A road sign having a number of useful features is illustrated below. The name-plate is made of heavy galvanized iron. The symbols are countersunk so as to give all possible protection to preserve the face of the letters from climatic conditions or defacement by stones or shooting. The letters are faced with aluminum over a well prepared and properly treated base coat. The face of the plate is covered with a high grade black iron elastic paint over a special base. Either tube or angle iron posts are furnished. The posts and brackets are either galvanized or treated with a special elastic gray iron paint, after having been pickeled for the purpose, and finished coat heat treated, but not baked. The road sign is manufactured by the Union Iron Products Co., East Chicago, Ind.

Union Iron Products Co.'s Road Sign.

Protecting Asphalt from Oil Drippings

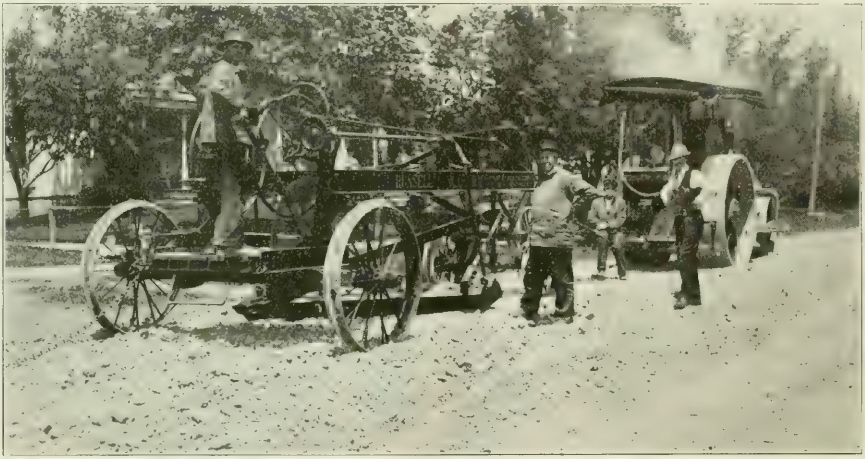
A sprinkling of sand about 2 ft. wide and ¾ in. thick is used on asphalt pavements in New York City to absorb oil and gasoline that drips from motor vehicles standing at the curb or parked in the center of the street.

Street sweepers keep the edges of the sanded area neatly lined. Fresh sand is applied each morning.

Rebuilding Old Macadam Pavement at Rate of 1 Mile Per Day

An economical method of remaking badly worn macadam pavement was employed this spring by the village of Seymour, Wis. The old macadam was scarified, dressed back, leveled and then rolled. The work was done with a Russell combination scarifier and road machine hauled by a 30 H. P. tractor. In carrying out the improvement 12 rounds were made with the tractor and machine. Of this, four rounds were for scarifying, four rounds for dressing back and four for leveling and rolling, the tractor serving as the roller. The labor employed consisted of three men. One mile of street was improved per day.

The road machine used on the Seymour work is easily and quickly converted into a scarifier. In scarifying, if the old road is very hard, only three middle teeth are used. On most roads, however, the machine will operate with the full complement of teeth. This method of road improvement is used extensively in Georgia, where a large number of the Russell Mogul combination scarifier-road machines are in use.



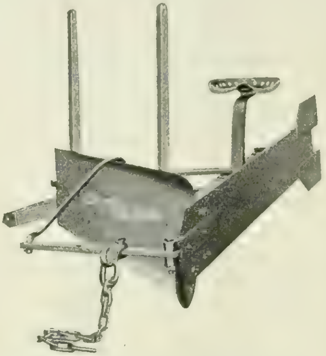
Remaking Old Macadam Pavement With Combination Road Machine and Scarifier.

Curing Concrete Pavements by Coating with Asphalt

The following method of curing concrete pavements is employed by Oliver R. Moll, of Redwood, Cal.: After pouring the concrete and as soon as it has set hard enough to permit an asphalt kettle or tank to be hauled over it, spray uniformly with hot asphalt. The object of this coating is to prevent evaporation of the moisture still in the concrete and to cause capillary attraction.

For pavements such as are used in California, where a 3/8-in. carpet of asphalt and screenings is specified, the paint coat should be heavier and screenings applied immediately.

The Martin Road Grader and Farm Ditcher



The Martin Road Grader.

An economically operated road grader that is coming into extended use in the South is illustrated. It is claimed for this machine that under the most extreme conditions it never requires more than four horses and two men for operation. The grader, with the exception of two minor parts, is made entirely of steel. The machine can be used for road dragging by replacing the cutting blade with a drag blade. And it also can be employed to advantage in digging or cleaning out drainage ditches on farms. The cutting blade on the grader shown in the illustration is 5 ft. long. The grader is manufactured by the Owensboro Ditcher & Grader Co., of Owensboro, Ky.

Industrial Notes

The Sullivan Machinery Co. has removed its San Francisco office from the Sheldon building, 461 Market street, to the Hobart building, 582 Market street. Ray P. McGrath is manager at San Francisco.

The Ingersoll-Rand Co. announces that at a meeting of the board of directors of the company, July 25, J. H. Jowett, formerly general sales manager, was elected vice-president of the company, and L. D. Albin, formerly assistant general sales manager, was appointed general sales manager. Mr. Jowett and Mr. Albin will continue to make the company's New York office, at 11 Broadway, their headquarters.

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The Deadlock Over Pipe Specifications as an Example of How Not to Solve an Engineering Problem

A committee of the American Waterworks Association, consisting of four hydraulic engineers and two representatives of cast-iron pipe manufacturers, has become deadlocked over certain proposed changes in standard specifications as to cast-iron pipe. This deadlock is so typical of similar disagreements, and relates to such an important matter, that it merits the consideration of all our readers.

The salient point upon which the manufacturers differ from the four engineers of this committee is the matter of changing the present standards as to the external diameters of pipe. It is contended by the four engineers that "a uniform outside diameter for the several classes of pipe for each nominal inside diameter is ideal." The reason for calling it "ideal" is that each different weight of pipe will couple with standard fittings. Up to the present this "ideal" has been attained only for pipe of 12-in. diameter and for smaller sizes. Now the four engineers of the committee urge this "ideal" for larger sizes, while the manufacturers urge the retention of the present limitation of the "ideal."

The question involved is obviously an ecomonic question, yet we have the curious spectacle of four eminent engineers insisting on a change of standards without supporting their contention by any estimates of the saving to water works plants consequent upon the change. Instead, they demand that the manufacturers shall produce estimates of the cost of making the change, and then, presumably, the four engineers will undertake to give proper consideration to such cost.

One manufacturer says that it would cost fully a million dollars to change the manufacturing equipment of all the plants to meet the requirements of the proposed new specifications as to size of pipe. Another manufacturer adds that it is impractical to estimate this cost under present conditions; and, further, that this is not the only element of cost, for the proposed new size would increase the manual labor and decrease the machine operations in pipe manufacture.

Now, while the four engineers of the committee are justified in asking for estimates of increased cost incident to effecting the proposed change in pipe sizes, they seem to be oblivious to the fact that they should have entered the court of engineering opinion "with clean hands"; that is to say, with careful estimate of the annual saving in cost that will follow the proposed change. They assert that it seems to them that the increased costs would be nominal. With equal propriety might the manufacturers reply that it seems to them that the savings from the proposed new standardization would also be nominal.

One manufacturer at least has furnished an estimate of cost that is not a nominal amount ($1,000,000), and has pertinently asked who is going to guarantee that this sum will be paid back to the manufacturers. Surely if there are to be savings in excess of, say, $1,000,000, there should be some assurance that out of those savings the manufacturers will be recouped. But no engineer rises to prove either that the savings will exceed $1,000,000 or any other sum, or to show how the manufacturers are to be recompensed for their additional cost. It is just such failure to approach an economic problem in a practical and complete fashion that has resulted so often in the charge that "engineers are pure theorists." And it is high time that engineers take vigorous steps to make this accusation futile by invariably being prepared to show both the costs and the profits resultant from any proposed project.

We doubt not that when the four engineers of this pipe committee come into a conference with a careful estimate of the saving or profits to be annually derived from the proposed change in pipe sizes, the pipe manufacturers will be willing to meet them with estimates of the costs of making the changes. It may then transpire that the costs will exceed the profits in which case the "deadlock" will automatically come to an end. If the profits exceed the costs, then there will remain only one question to be settled: How will those profits be applied so as to recoup the costs to the manufacturers?

A Waterways Commission Bill that Reminds Us of a Cuban Army

A bill has passed the House and is now before the Senate providing for a Waterways Commission of seven members, at annual salaries of $7,500 each. One of the members must be an active or a retired officer of the Engineer Corps of the army; another member must be "an expert hydraulic engineer from civil life." As for the five remaining members nothing is said as to qualifications. Presumably they are to be politicians.

Probably the engineering profession should rejoice at being represented at all on any commission that is to study engineering problems, for only a few years ago it was the almost universal custom not to put engineers on such commissions. Times do improve. Yet an engineer can scarcely refrain from asking why this waterways commission need consist of more than three men at the most.

The proposed commission is to study waterways, waterpower, irrigation and drainage problems in America and report to Congress a plan for the general development of hydraulic resources—in fact, all resources dependent on the utilization of water. An initial appropriation of only $100,000 is provided, the smallness of which serves to emphasize the desirability of reducing the number of the commission from seven to three, or even to one.

This is a bill of the sort that civil engineers, through their societies, should assist in framing. The plan of making a general survey of our hydraulic resources is commendable, but who is so competent to pass upon details of a bill of this sort as are civil engineers? We believe that among engineers experienced in the execution of the provisions of such a bill there would be practical unanimity on two things: First, that a commission of one engineer is preferable to a commission of seven men only two of whom are engineers. Second, that if only $100,000 is to be appropriated to start with, the work of the commission should be limited to some one branch of hydraulic problems, such, for example, as waterpower resources.

A bill that provides for a commission so large that half the first appropriation is eaten up by the salaries of the members would be on a parity with a railway company appropriation of $100,000 for a railway survey, of which $50,000 would go to seven chiefs of party. The creatures of this bill remind us of a Cuban army—more generals than privates, and slender commissary for all.

Only 11,621 Civil Engineers Graduated in 22 Years

In another editorial article will be found data showing the number of engineering students in 1916 and the total number graduated in the last 22 years. From these statistics we find that of the 35,777 engineers graduated in 1895 to 1916 inclusive, nearly a third, or 11,621, are civil engineers. Proportionate to the other classes of engineers this is a large number, but it is discouragingly and astonishingly small when rated against a total population of more than 100,000,000 people, being scarcely more than 1 in 10,000.

A more encouraging fact is that of the 33,106 students in engineering in 1916 there were 7,251 in civil engineering courses. This would indicate that about 1,800 would graduate in 1916, if the four classes were equal in numbers; but, as is well known, there is a weeding out of students after the freshman year, which is often very pronounced. In 1916 there were 1,236 civil engineering graduates.

Prof. C. R. Richards, Dean of the College of Engineering of the University of Illinois, has begun a publicity campaign to increase the entrance classes in the university, stating that "it is important that the youth of the country realize the need of the nation for men having adequate training in technical work." He says:

> The war in Europe has been a war of engineers and of the product of engineers, and every effort has been made by the European powers to conserve and increase the supply of men who are competent to carry on the work of the industries upon which the success of the war depends.

We hope to see the deans of all our engineering colleges adopt publicity methods that will result in marked gains in the engineering attendance this coming year. Now is the time to act, not only through the daily press but by advertisements and articles in the magazines.

Should Managers of Technical Men Require Them to Read and Study an Hour Daily?

We are led to ask this question because of two facts known to us that are known to relatively few people: First, that in spite of their training engineers and other technical men are only slightly more given to systematic reading than are other intelligent men. Second, that the world's progress in scientific and economic knowledge is so rapid, and the amount of new information so vast, that no technical man can keep even approximately up to date unless he studies systematically and considerably.

As editors we are compelled to read carefully a great deal and to scan a vast deal more. As authors of engineering books we necessarily review and abstract engineering literature for 20 years or more back. As professional men going among professional men we see what many engineers and superintendents are doing and are not doing. Of their sins of omission none is more startling than the prevalent failure to read and digest and compare currently published technical data.

Some men excuse their failure to study on the ground that "grinds" never advance, anyway. Others, on the ground that they can not possibly remember everything new, and may as well defer study until a specific problem entails it. Still others aver that they have mastered the "general principles" of their profession or business and know where to search for the details when needed, so that continuous study is no longer essential.

There are, of course, many other excuses, but not one that we have yet heard will bear analysis. A hydraulic engineer of 15 years' experience said to the editor that he had ceased reading all engineering periodicals, for they merely retold facts that he already knew. Yet this man had designed and built several filters to remove fresh water algae when the desired result could have been accomplished at far less cost by treating the reservoirs with copper sulphate. This was 10 years ago when the copper sulphate treatment was comparatively new, but had this hydraulic engineer been a reader of the periodicals that he criticised, he would have learned of the new process.

Today there are a lot of self-satisfied men just like the man above referred to, who through failure to read have quite as little knowledge of the economic efficacy of liquid chlorine treatment for typhoid as this man had of copper sulphate treatment for algae.

We raise the question whether it will not be advisable for every employer or manager of technical men to require them to read and study, say, an average of six solid hours weekly. It is our opinion that such a procedure would repay the employer richly, even if the entire six hours of study were at the employer's expense.

For example, in the various departments of a city the engineers and superintendents of technical work, such as water works and street cleaning superintendents, might be required to meet in a study room one hour a day. A course of technical reading should be outlined for them to begin with, but they should be given considerable freedom of personal choice. Memoranda should be made of usable facts discovered through such study, and these memoranda should be periodically reviewed in order to charge the memory with facts.

One of the grand mistakes of our modern educators has been the iteration and reiteration that how to think is far more important than "cramming the memory with facts." We reserve for a later editorial a discussion of this mistake. Thinking is impossible without memorized facts, and the better thinker is usually the man who has the greatest store of usable facts in his mind and in printed or written storage reservoirs to which his memory directs him. In his recent address at the presentation of the Fritz Medal to Prof. Elihu Thomson, Mr. E. W. Rice, Jr., said:

> He seems to possess an almost intuitive insight into nature and her ways, probably because of the quickness and accuracy of his perceptions, combined with the most remarkable depth and range of his scientific knowledge, all helped by a marvelously retentive memory.

You that have been taught to decry the memorizing of usable facts may well begin to question how sound were the theories of those that taught you; and you may well ponder the fact that the president of one of the greatest manufacturing companies in the world—the General Electric Co.—thus speaks in eulogy of Prof. Thomson's "remarkable knowledge" and "marvelously retentive memory."

Calling a Thing "Ideal" Does Not Make It Economic

There is a curious sort of fallacy which no book on logic, so far as we know, even mentions. We refer in general to the fallacious attempts to solve economic problems by the mere use of verbal phrases that are not quantitatively definite, such, for example, as the terms "ideal" or "perfect." In another editorial in this issue we have quoted an engineer who speaks of a certain "ideal" uniformity of exterior diameter of cast-iron pipes of varying thicknesses. Apparently this engineer thinks that he has at least approached a definite solution of an economic problem because the result is an "ideal" dimension.

Whenever such a word as "ideal" or "perfect" is used, there is not only implied some standard of "perfection," but a standard that has reference to some particular quality that is measurable. If a quality is not measurable even approximately, it can not be compared, and in the absence of comparison there can be no such thing as "ideal" or "perfect" example of a given quality. Furthermore, in an economic problem, all "qualities" must be measured in the same units before a final conclusion can be drawn. Usually this means that a unit of value, such as the dollar, must be applied throughout.

All this seems self-evident, yet we repeatedly come across violations of this logical principle, even among engineers whose mathematical training is supposed to inculcate correct methods of reasoning on economic matters. Apparently, then, the study of mathematics is not in itself a sufficient drill in the principles of logic. And if so, every engineer should study logic as a science in itself. We do not refer to the logic of the textbooks alone, for textbook logic is at present a pretty sorry substitute for a real treatise on the art and science of thinking. We mean that engineers should read some good book on logic carefully, and then re-read it critically, and later on proceed to make notes of their own on methods of thinking, on fallacies, on the use of language as a reasoning tool, etc. There is no royal road to a knowledge of logic. The attainment of greater and more accurate reasoning ability occurs to some degree as a by-product of one's everyday work; but, if it is to be attained in high degree, the reasoner must direct his attention to the methods of reasoning.

Proposed Exemption of Engineering Students from Army Draft.

Under authorization of Secretary of War Baker, Mr. P. P. Claxton, United States Commissioner of Education, has addressed a letter to the presidents of engineering and technical schools urging them to seek exemption of engineering students from war service. This letter not only gives cogent reason for such exemption, but shows what a surprisingly small number of engineers (35,777) have been graduated the last 22 years. The letter follows:

The successful prosecution of the war depends in large degree on the services of scientific and technical experts. It is of the utmost importance that the supply of men who have had advanced technical training should not be cut off more than is necessary. In view of this fact the war department believes that students in technical schools and colleges who are within the age limits of the selective draft should be treated in the same manner as the workers in the industries which are devoted to the manufacture of war materials. Under this ruling the presidents of colleges and technical schools may properly urge the district exemption boards to exempt students in their institutions who give promise of special aptitude for the technical and scientific professions until these students have finished their courses. It is expected that institutional officers will exercise due caution and will not claim exemption for students whose success in technical careers is open to doubt.

It should be clearly understood that each case is to be considered by the district exemption boards on its own merits. Students in technical schools are in no wise exempt as a class. No class of persons are exempt from the operation of the selective draft except those specified in the act.

I am bringing this matter to your attention with the authorization of the Secretary of War. The importance of it is emphasized by the enclosed sheet, indicating the small number of available engineers in the country at the present time.

The data enclosed are as follows:

Graduates in engineering, 1895 to 1916, inclusive:

Chemical engineering	1,172
Civil engineering	11,621
Electrical engineering	6,357
Mechanical engineering	11,291
Mining engineering	3,195
Metallurgical engineering	150
Engineering (general)	1,897
Marine engineering	15
Textile engineering	48
Agricultural engineering	31
Total	35,777

Except for the years 1915 and 1916 these numbers include both bachelors' and graduate degrees.

Total number of graduates in engineering in 1895 was 752.

Graduates in engineering in 1916:

Chemical engineering	340
Civil engineering	1,236
Electrical engineering	1,098
Mechanical engineering	1,164
Mining engineering	267
Metallurgical engineering	12
Engineering not specified	163
Marine engineering	9
Textile engineering	12
Agricultural engineering	5
Total	4,306

Students in engineering in 1916:

General engineering	5,485
Chemical engineering	2,774
Civil engineering	7,251
Electrical engineering	7,098
Mechanical engineering	7,707
Mining engineering	1,790
Other types of engineering	1,001
Total	33,106

Waterpower Development Needed to Conserve Coal and Oil

When an official of the Standard Oil Co. urges owners of automobiles to economize gasoline, when the governor of California finds that stocks of petroleum are being rapidly depleted in a State that produces one-fourth of the world's supply, and when the prices of every kind of fuel have doubled within three years, surely no further facts are needed to emphasize the importance of developing our latent water powers.

Secretary Lane states that 35,000,000 H.P. of available water energy is uselessly dissipating itself. Would it not be wise to have rough Government surveys and estimates made of the cost of developing the various sources of waterpower in America? It is interesting to know that there are 35,000,000 H.P. available, but the economic question is what parts of this huge total can be used at less annual cost than for steam power.

This is an engineering problem of vast national importance, which the war has merely served to emphasize. Geologists have been telling us for a generation that we are already in sight of the exhaustion of our mineral fuels. But with characteristic lack of vision the public has failed to look far forward, and the politicians have been almost as nearsighted. It is distinctly up to engineers and engineering societies to put the public eye to the telescope and hold it there till the nation sees our exhausted coal mines and depleted oil wells of the not distant future.

Responsibility of Water Company for Injuries Caused by Curb Box Set Above Grade

To the Editor: Our water boxes (curb boxes), like those of many other companies, vary in height from the grade level, running from level with the ground to 3, 4 and 5 in. above the ground, as the case may be. When there is an application made for service we make the connection and run our pipe just inside the curb line, and ordinarily leave it flush with the ground. Quite often, however, the owner will say, "Leave it up 3, 4 or 6 in., as I wish to raise my grade, or come to a newly established grade," and we then do as he requests. On the other hand, there are many curb boxes that have been in for a great many years, which have been raised or lowered by the property owners as suited their fancy on the shifting grade as often given by the city engineer. We had always supposed our responsibility ceased when putting in the shutoff, it being put in for the convenience of the water taker as well as ourselves; but recently suit has been brought against our company by a party who deliberately walked across the owner's ground (the house being on a corner) and then, instead of using the walk to the street, where his horse was standing, walked across the lawn from the sidewalk to the curb, catching his toe underneath a curb box that was raised some 3 in. from the surface of the ground.

Have you any data to which you could refer us? This, in a way, is a novel suit; so far we have been unable to find any Water Superintendent who has had a like case. We would much appreciate any case or cases to which you might refer us.

——— Water Works Co.

Method and Cost of Thawing Frozen Ground with Steam

The city of Pocatello, Idaho, during the winter of 1916-17 experienced the longest cold spell ever recorded there, with the result that the people were inconvenienced considerably on account of frozen water pipes. Between Jan. 10 and 15 a 4-in. cast-iron water main 4,000 ft. long through the best residential street in the city was frozen solid from end to end. An effort was made to thaw it out with electricity, but it was found that too many joints were broken and it would be impossible to get water through it without digging most of it up.

Considering the cost of temporary relief needed at once, the cost of previously announced increase in wages to take effect April 1, the loss of revenue for three months, the cost of making service connections to a temporary main laid on top of the ground if the frozen main was left alone until summer, and the advantage of having the pick of the labor supply, it was decided the cheapest thing to do would be to replace the frozen main and lay it to grade immediately. The old main was laid at a depth of only 30 to 40 in., but this was to have been increased when the street was graded preparatory to paving. The following method for thawing the ground was developed by Edgar C. Smith, Superintendent of Water Works, and worked very successfully:

A double line of 1½-in. pipe was laid over the site of the trench and covered about 6 in. deep with sand. Steam was supplied from a traction engine at 75 to 100 lb. pressure. The first day a 180-ft. stretch of pipe was placed, but it was found that hot water and steam was being returned to the boiler, showing that all the heat generated was not being used. A little experimenting proved that thawing a 300-ft. stretch at a time gave the best results. In the morning the gang would throw the sand off the pipe in about 10 minutes and the traction engine would pull the pipe to the next block. A team would haul the sand and have the pipe covered again by 10 o'clock and steam would be kept in the pipe until the next morning.

The ground was frozen to a depth of 4½ ft. After applying the steam for 24 hours the ground was clear of all frost for a depth of 2½ ft. and was very easily dug. Below that depth the frost was so rotten that the earth was easily loosened with a pick.

Water was supplied to the engine with a street sprinkler tank, but as the condensed steam returning through the pipe was turned into the tank not much water was used, and the temperature of the returning water was just enough to keep the tank from freezing.

The total daily cost of thawing the ground was as follows:

Rent of traction engine per day	$ 3.00
Day fireman	5.00
Night fireman	4.50
1 ton of coal per day	8.00
1 yd. of sand per day	.75
Team and one man moving sand, hauling water, etc., ½ day	4.50
Gang of 20 men 15 minutes removing sand from pipe = 5 man hours	1.87
Total	$27.62

Total length of trench opened per day, 300.
Cost per foot for thawing, $0.092.

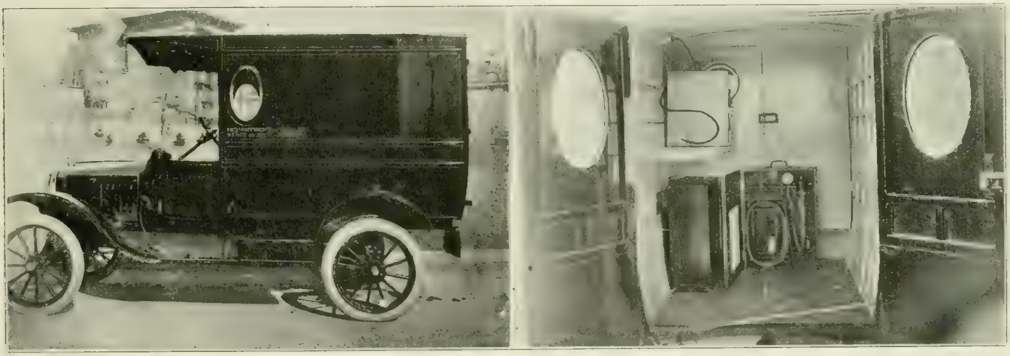
Each of the 16 camps now under construction for National Guard divisions of the United States Army will require approximately 19 miles of piping for water supply purposes.

Traveling Field Laboratory of New Jersey State Department of Health

In New Jersey the supervision of the public water supplies, the majority of the sewage disposal systems, and the pasteurization of milk and its products are entrusted to the State Department of Health.

The supervision includes, among other things, testing the efficiency of water filtration and treatment plants, sewage disposal plants and the various stages of the pasteurizing process by chemical and bacteriological examinations. To accomplish this work the department maintains a force of trained men who work from Trenton as a base, perform the necessary preliminary chemical or bacteriological work and return to the State Laboratory at Trenton in most every instance at the end of each working day where such samples as may have been collected are turned over to the laboratory to complete the tests.

It has been found that this system is troublesome, time consuming and is not conducive to the best results. It frequently becomes necessary to make a week's test of the operation of a water filtration or sewage disposal plant which has always been found to be attended with many difficulties. It has been shown on several occasions that it would be much better if the department had some means by which it could reach towns threatened by an unsafe water or milk supply more quickly than by relying on trains which in some sections of the State are exceedingly irregular. The department, therefore, recently equipped an automobile with a laboratory and with the necessary chlorine disinfecting apparatus. The automobile is ready for service at any time and should a water treatment plant become disabled and the quality of the water supplied to the public be rendered unsatisfactory and unsafe, the plant can be reached within a comparatively short time and the chlorine gas apparatus installed and operated.



Exterior and Interior Views of Traveling Field Laboratory of New Jersey State Department of Health.

The automobile has a special body which is of the same type as the body of a delivery wagon. It has wooden doors at the front at the rear of the driver's seat and at the back of the car which are fitted with suitable locks. The interior of one side of the car is fitted with a laboratory bench and the necessary equipment for laboratory work. Two 37° C. incubators were installed in which cultures of bacteria can be grown. These incubators are made so that they may be either taken from the car and used on a 110-volt electric circuit or they may be left in the car and run from a storage battery at 12 volts.

Experience has demonstrated that all places where milk is commercially pasteurized must be subjected to official control, which immediately presents a problem as to how this can best be accomplished. For nearly two years the department has endeavored to check up the various pasteurizing outfits by taking samples, for bacteriological examination, of milk in its raw state and at different stages in the pasteurizing process.

On examining the milk from creameries located in immediate proximity to the State Laboratory, samples after collection are brought to the laboratory to be plated, incubated and bacteria subsequently counted. In collecting samples from pasterizing plants located some distance from the laboratory it is found impossible to deliver them there until long after closing hours. For this reason the necessary agar plates are made while at the creamery, the plates being brought back later in the day and placed in the incubator, where after 48 hours' growth they are counted by a member of the laboratory staff. This procedure is found quite satisfactory in all cases except in the extreme upper end of the State. Here the time spent in traveling to the various creameries as well as the expenses incident thereto, makes the collection and transportation of samples under the plan outlined above impracticable.

Generally speaking, the shorter the time between the collection and examination of milk samples, the more accurate will be the results. With the assistance of the department's new motor laboratory, which can be stationed at some central point in the remote sections of the State, samples can be collected, plated and brought to the auto-laboratory for incubation and counting. Besides effecting a great saving of time and expense, the general efficiency of the work will be materially enhanced.

While this traveling laboratory was designed and largely planned by C. G. Wigley, Chief Engineer of the department, and will ordinarily be assigned to the work of the Bureau of Engineering, it is to be of service to the whole department and may on occasions be also used for the control of epidemics of communicable diseases. One of the first uses to which the equipment will be put will be that of examining the milk and water supplies at the concentration camps of soldiers in the State of New Jersey.

Objectionable Features of Sprinkling Filters and the Cause

In connection with studies for a main drainage and sewage disposal project for the area tributary to Jamaica Bay, New York, Mr. Kenneth Allen, Engineer of Sewage Disposal for the Board of Estimates and Apportionment of New York City, collected information on the objectionable features of sprinkling filters in connection with sewage treatment works. Inquiries were made concerning some 40 municipally operated plants, and answers were obtained from 14 of these, including the more important installations in the United States. A summary of the replies is given in Tables I and II. The results of Mr. Allen's investigation are given in a recently issued report, from which the matter in this article is taken.

So far as can be learned from the answers as well as from personal visits to a large number of plants it is Mr. Allen's opinion that if the sewage is reasonably fresh and the plant properly designed and operated, odors will rarely be noticed at a distance greater than 600 or 800 ft. But two of the cities heard from—Baltimore and Columbus—have had complaints traceable to sprinklers, and in both cases the sewage is delivered in a septic condition.

The question arises: How old must sewage be to reach this condition? Obviously this depends on the constituents of the sewage, the temperature, its access to the open air and its possible contact with decomposing deposits.

There is so little accurate information to be had as to the velocity of flow in sewerage systems that it is difficult to assign any definite period of collection that is necessary to bring the sewage to a septic condition. It would obviously be unfair to take this period as that required to deliver the sewage from the most extreme point of the system, as the tendency to septicize this presumably small portion of the whole, would be partly neutralized by the larger subsequent volumes of inflow containing a residium of oxygen. Probably a point somewhere between the center of population and this extreme point would be more reasonably assumed at the point from which the oxygen is gradually depleted until reaching the treatment plant.

Mr. F. D. Smith, Chief Engineer of Sewage Works, Metropolitan Water and Sewage Board of Massachusetts, writes:

> The sewage of the Metropolitan sewers is in general in a septic condition when discharged through the outfalls owing to the length of the mains. Some of these mains, together with the lateral sewers, have a length exceeding 25 miles.
>
> I am not able to state definitely the length of time before the sewage could be termed stale or septic. The chemist of the State Department of Health of this state, who makes examination of the condition of sewage in our sewers, informs me that after 20 to 24 hours, depending upon the season of the year, they regard the sewage as septic.

By reference to Table I it is noted that the sewages of Batavia and Schenectady reach the plant at about the time when becoming septic.

At Batavia decomposition seems to be promoted by deposits in the sewers as "if the sewers are flushed once a year during the summer months the sewage arrives at the plant in a fresh state." This would be expected as the extreme distance traveled is but about 2½ miles.

At Schenectady the extreme flow is about 6 miles and that from the center of population about 4½ miles as measured along the sewer. A careful computation indicates the extreme distance and time of travel by two routes to be: Route 1—From State St. 5.9 miles, 4 hr. 36 min. Route 2—From 15th St. 6.45

TABLE I.—ODORS DUE TO SPRINKLING FILTERS.

Town.	Volume of sewage gal. per day.	Condition at delivery.		Distances that odors are			
				Noticeable.		Objectionable.	
		Tanks.	Nozzles.	Unfavorable conditions.	Once a month in summer.	Unfavorable conditions.	Once a month in summer.
Atlanta, Ga.	13,000,000	2 plants fresh 1 plant stale	Fresh Stale	400 ft. 700-800 ft.	......	......	......
Baltimore, Md.	45,000,000	Stale	Septic	⅓ to ½ mile	......	⅓ to ½ mile	......
Batavia, N. Y.	2,000,000	Slightly septic	Slightly septic	300 ft.	......	None	None
Bloomington, Ind.	600,000	Fresh	Septic	1,000 ft.	......	800 ft.	......
Chambersburg, Pa.	700,000	Fresh	Fresh	½ mile	½ mile	1,000 ft.	1,000 ft.
Columbus, Ohio	21,000,000	Septic	Septic	1 mile	¼ mile	1 mile	¼ mile
Fitchburg, Mass.	2,123,000	Fresh	None over 8 hours old	300-400 ft.	......	None	None
Gloversville, N. Y.	2,800,000	Fresh	Fresh	500 ft.	500 ft.	None	None
Indiana, Pa.	657,000	Fresh	Septic	200 ft.	400 ft.	......	400 ft.
Lebanon, Pa.	800,000	Fresh	Septic	Practically no odor		300 ft.	None
Philadelphia, Pa.	1,250,000	Fresh	Fresh	500 ft.	Ordinarily less than 50 ft.	500 ft.	Ordinarily less than 50 ft.
Reading, Pa.	6,000,000	Fresh	Settled 7 hrs.	300 ft.	......	300 ft.	......
Schenectady, N. Y.	10,000,000	Fairly fresh	Nearly stale	700 ft.	......	700 ft.	300 ft.
Washington, Pa.	1,400,000	Septic	Septic	1,500 ft.	400 ft.	1,200 ft.	300 ft.

TABLE II.—EFFECT OF SEWAGE TREATMENT PLANTS ON PROPERTY VALUES.

Town.	Distance to nearest residence.	Complaints due to odors, flies, etc.	Effect on property values due to construction and operation of plant.
Atlanta, Ga.	300 ft.	None	Property values about plants have increased
Baltimore, Md.	1,300 ft.	Several complaints due to odors and flies	None
Batavia, N. Y.	381 ft.	None	None
Bloomington, Ind.	1,500 ft.	Complaints from flushing about 3 times a year. None from plant.	......
Chambersburg, Pa.	600 ft.	None	None
Columbus, Ohio	1,300 ft.	Complaints due to stale condition of sewage	An alleged decrease. Unable to verify
Fitchburg, Mass.	1,000 ft.	None	None
Gloversville, N. Y.	900 ft.	Complaints due to sludge beds—none to filters	4 properties 200'-600' from sludge beds depreciated 25-33⅓%
Indiana, Pa.	1,300 ft.	One complaint due to sludge removal	None
Lebanon, Pa.	600 ft.	None	None
Philadelphia, Pa.	2,000 ft.	None	None
Reading, Pa.	1,300 ft.	Complaints due to cleaning tanks—not to filters	None
Schenectady, N. Y.	1,100 ft.	Complaint due to undigested sludge in early operation of plant	None
Washington, Pa.	1,000 ft.	Complaints from discharge of undigested sludge. None for 2 years	Apparently none

miles, 5 hr. 56 min. The sewage is fairly fresh on arrival, but is approaching staleness on reaching the nozzles after settling.

From Table I it also is shown that the sewage arrives at one of the Atlanta plants and at the Baltimore, Md., Columbus, O., and Washington, Pa., plants in a stale or septic state.

The extreme distance of travel at Atlanta is about 5 miles, and that from the center of population 4½ miles. The maximum time of travel is about 4½ hours, due in part to the flow for about ¾ mile through an old creek bed which will be replaced by a sewer later when the sewage is expected to arrive in a fresh condition.

At Baltimore the sewage from the center of the city travels about 8 miles and is some 5 hours old when received, although some is probably derived from a distance exceeding 10 miles.

At Columbus the center of population is stated to be 4 miles, but the most extreme point 10 miles from the plant.

At Cleveland a travel of 5 miles renders the sewage "distinctly stale."

From the above it would appear that sewage brought from a distance of over 6 or 8 miles from the center of population under ordinary conditions of flow and in warm weather is likely to arrive in a stale condition. This is confirmed by the condition of the sewage reaching the sewage testing station at Cleveland, where it arrives in this condition when 6 or 8 hours old, while, indicating this to be about the limit, the sewage from Fitchburg reaches the plant when most of it is not over three but some of it nearly eight hours old in a fresh condition.

This conclusion, being based upon so few examples must of course be considered as tentative and liable to modification and in any case the limiting time depends, as already pointed out, on such matters as temperature and contact with the air.*

The foregoing discussion indicates in a general way that a nuisance may arise from a sprinkling filter plant; that experience in other cities goes to show that such nuisances are more apt to be traced to other features of the plant, such as sludge handling, than to the operation of the filters themselves; and that odors are liable to be produced during warm weather by sprinkling filters handling a stale or septic sewage that may affect property values located a quarter of a mile or more from the plant.

It is probable, too, that sewage delivered from ordinary septic tanks to sprinkling filters is more liable to cause odors than when delivered from Imhoff tanks, not only on account of the longer retention customary with the former type, but on account of the withdrawal of oxygen due to contact with the decomposing sludge and to absorption of the malodorous gases evolved during his decomposition.

Where large volumes of sewage are to be treated, therefore, sprinkling filters should handle fresh sewage only, or else be placed far from habitable property.

In the selection of a method of oxidizing treatment for a peroid of 40 years or so hence the more sluggish flow, and consequently nearer approach to a septic condition of the sewage on reaching the plant that will obtain during the early years of operation, should not be overlooked. With a velocity of, say, 1.5 instead of 3 ft. per second, the age of the sewage would be doubled and in addition there would be the greater liability of deposits, resulting in an additional draft on the oxygen remaining in the liquid, with a further reduction of the time required to bring about anaerobic decomposition. Another consideration which has not been touched on is the area required. If, for instance, it should turn out that the activated sludge process were otherwise advantageous, it would have the additional merit of requiring much less area —probably from a quarter to a fifth of that necessary for sprinkling filters. In some localities this would be a consideration of much importance.

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*In the Emscher district in Germany sewage effluents are carried many miles in open channels with an average velocity of 2.3 feet per second and it is claimed that instead of becoming septic the sewage improves through contact with the air and the effect of the sunlight.

Unloading Pipe from Gondola Cars by Motor Truck

By an ingenious arrangement of block and tackle the Public Service Department of Glendale, Cal., made its motor truck load itself with pipe from gondola cars. For unloading the cars a 35-ft. gin pole was erected and guyed to the ground. As the work of hauling was done with an electric light line crew the erection of gin poles and guying was simply a matter of every-day routine and required but little over an hour. A set of double blocks with 1-in. manila rope to which was attached a ½-in. steel guy sling fitted with hooks was used for lifting the pipe out of the car. When ready to load, the end of the line was snapped onto a hook at the back end of the truck, the piece weighing 2,100 lbs. was hoisted to clear the car and the end of the manilla line snubbed.

The truck then backed under the pipe and the pipe was lowered away. This operation was repeated three times with each load and the total time required from the time the truck arrived at the car until it left with the load tied on was between 6 and 7 minutes.

In hoisting out of the car it was generally necessary to attach a small line with double blocks from the pipe to the side of the car. This was eased off gently as the pipe started to leave the bottom of the car in order to prevent injuring pipe or car. In loading the crew was disposed as follows: One man handling truck, one man on car hooking slings into each end of the pipe and handling the small block which prevented pipe from thrashing around as it was lifted, one man to receive pipe and get it onto the bed of the truck, one man to snub rope when pipe was lifted and lower away at the proper time.

For unloading the truck two skids 4x6, about 9 ft. long, shod one end with iron so as to hook into the bed of the truck, were used. A sling of 1-in. rope was thrown over each joint of the pipe and snubbed at the opposite side of the truck and the pipe was readily eased down into place.

In all 9,000 ft. of 20-in. cast iron bell and spigot pipe was unloaded and distributed. This was accomplished by means of a 2-ton Packard truck and crew of four men. As high as 100 tons of pipe per day were handled, working two shifts of men, and the truck running for about 15 hours. This included spotting the car, taking pipe out of the car, tying the load on the truck, hauling to the job a distance a little under a mile, and distributing along the job. Several round trips were made in 18 minutes where the haul was less than ½ mile each way. All loads included three lengths of 12-ft. pipe.

H. B. Lynch is Manager of the Public Service Department of Glendale, Cal.

Operating Methods at Chain of Rocks Filter Plant, St. Louis, Mo.

The Chain of Rocks filter plant was placed in operation in the spring, 1915. The total cost of the plant was $8,550,000 and its rated capacity is 160,000,000 gal. daily. The method of purification includes grit removal, softening with lime, coagulation with iron, sedementation, coagulation with sulphate of alumina, filtration, and sterilization with chlorine. The methods of operating the plant are described by Mr. C. M. Dailey, engineer in charge of the Supply and Purifying Section, Water Division, Department of Public Utilities, St. Louis, in the May-June Journal of the Engineers' Club of St. Louis, from which the matter following is abstracted.

In commencing operation of the plant, each controller was adjusted and the filter unit put in service. The time required to put the entire plant in operation was about 30 days.

The adjustment and testing of the nine Venturi meters for the raw water, wash water and chemical solution, the orifice for measuring the chemical solution, the recording pressure and elevation gages received attention in the order given. In the meantime the operating force was instructed to wash at a low rate (18 in. vertical rise per minute), and to start the washing very slowly until all the air was expelled from the bed.

When all the machinery was in working condition, experiments were conducted as rapidly as possible to determine the best method to follow in operating the filters.

Tests for color and turbidity and determinations of the bacterial content of the water were regularly conducted under the direction of the chemist, with the expectation that the results of these tests could be used daily for regulating the plant operation. It was soon evident that the time necessary for the incubation of bacteria, brought these results too late to be of direct service, so that modification of the treatment had to depend upon the turbidity and color tests, leaving the bacterial results to follow later.

When the plant was first put in operation the aluminum sulphate solution lines which were constructed of 8-in. tiles and 4-in. fiber pipes failed to stand the slightest pressure, and dry aluminum sulphate was added to the water in the influent flume, starting the latter part of May, 1915, and it was not until July 7th that it was added to the water in the coagulation basins. This necessarily caused slightly turbid effluent water except when a good film of mud and aluminum hydroxide was formed on the sand, which incidentally made the turbidity tests in the filter operation of more importance than they otherwise would have been.

Turbidity tests of the effluent water were taken every 10 minutes from the time a filter was put in operation until the rate of filtration fell off, due to clogging of the sand. On several filters operating at different rates, the results were erratic in regard to the amount of turbidity but were uniform in the following respects: The first filtrate amounting to about 5,000 gal. was clear, and following this a quantity, varying greatly, sometimes exceeding over 18,000 gal. of turbid water, followed by a clear, effluent until the loss of rate fell off due to clogging of the filters; it was also observed that the same filter running at a low rate allowed a smaller quantity of turbid water to pass than when running at a higher rate. Filters having coarse sand allowed more turbid water to pass than ones having a layer of fine sand on top, the effective size being a poor indicator of the probable results. These results raised the question of at how low a rate a filter should be run to produce the minimum quantity of turbid water, and how long it should operate at this rate. Tests were made on several varying from 5 M.G. per day to ½ M.G. per day, those being the maximum and minimum quantities which could be automatically controlled. These results, as before, were erratic as to the amount of turbidity but uniform in two respects: First, the lower the rate, the smaller the quantity of turbid water passed; second, that after a period from 40 to 60 minutes running at a ½ M.G. rate, the rate could be raised to any quantity which could be controlled without increasing the turbidity. In this series of tests it was observed that after washing, when a large amount of aluminum sulphate was added to the water as it entered the bed, a smaller quantity of turbid water was delivered by the filter. The turbid water left in the filter below the wash water gutters, after washing, seemed to produce a much larger flock when mixed with the influent while filling the filter, which led to another series of tests to determine, if possible, a method for treating this remaining water, to reduce the quantity of turbid water delivered directly after washing.

Various quantities of dry aluminum sulphate were added to the water in the central gutter while filling the bed after washing. The filter was put in operation after being allowed to stand for a length of time varying from a few seconds to an hour, and at the same time varying the rate of filtration. The results clearly showed that a quantity of aluminum sulphate required to produce a heavy flock, about 14 lbs., and filtering at ½ M.G. rate for 40 to 50 minutes gave the best results, reducing the amount of turbidity often to ¼ part per million and never exceeding two parts. No advantage was obtained by leaving the bed standing for any length of time after filling.

At first when a filter needed washing the influent was shut off and the bed allowed to operate until the water fell below the top of the wash water gutter, when the washing was started and the quantity of water above the sand was wasted with the wash water. Numerous tests were made by allowing the filter to run after the influent water was shut off until the bed was drained. The results were uniform, showing a good effluent until the water level was far below the top of the sand, but the imprisoned air in the sand usually broke the film cracks appearing along the walls and a contraction of the film seemed to cause checks as the water reached a point a few inches above the sand. Undoubtedly a poor effluent would be produced by the water passing through the broken film, but all the water in the underdrain system and gravel must pass before this water could reach the effluent flume so there was no danger in drawing the water down to within an inch or two of the sand. If the water is drawn below the sand, packing occurs and the bed does not break up properly when washing, hence nothing is gained by drawing the water below the film on the sand.

The amount of filtrate necessary to be wasted after washing was studied and conclusions reached that it was unnecessary to waste any water with the adopted method of low rate filtration for one hour and treating each bed after washing.

As to the amount of wash water required and the best rate of washing, some uncertainties still exist, and probably will continue to do so, as the kind of material carried in suspension, the time between washings and the quantity of aluminum hydroxide on the sand greatly influences the quantity of wash water necessary at any rate of washing. At first a low rate of wash was used, about 18 in. vertical rise per minute; this was continued for about six months, resulting in the formation of mud balls varying in size from ⅛ in. in diameter to 1½ in. in diameter, most of them being of the smaller size; the rate was then raised to 21 in. and finally 24 in. per minute vertical rise, at which rate some of the smaller particles of sand would rise nearly to the wash water gutters. The high rate seemed to prevent the increase of mud balls but did not eliminate the ones already formed. Screens having ¼ in. mesh mounted on wooden frames were drawn through the sand while washing; usually after screening the sand in this manner from five to ten times, most of the mud balls were removed, but unless there was a very even distribution of wash water spots or hard lumps in the sand would occur.

On one filter bed it was found that the north side washed at a much higher rate than the south side. The north side was cut off with blank flanges and on washing the south side alone it was found that the greatest amount of wash water possible to get through this side was 9,600 gal. per minute, or 22 in. vertical rise per minute with the maximum head of 35 ft. on the strainer system. All the sand and gravel was removed in sections and many of the holes in the strainer plates were found to be plugged with cement and sand grains.

The holes were cleared by hand at a cost of $150, and when put in service, the cleaned side washed at a slightly greater rate than the other side. It was very difficult to determine a slight difference in the rate of washing of the two sides and in order to have some means of determining this a device was constructed for collecting samples of sand simultaneously at various distances below the wash water gutters while washing. This sand collector consisted of 15 telescopic cans 3 in. in diameter and 3 in. high provided with ¼x¾ in. openings near the top, covered with rubber slip valves, each can having an air vent projecting above the water when submerged. The cans were mounted on a suitable wooden frame and lowered into the sand while washing, the slip valves removed, thus obtaining samples of sand at various depths. From these samples the distance from the top of the wash water gutters to the sand while washing, was determined within 3 in., and the location of mud balls as well as the grading of the sand was shown.

The washing of a filter seems to be largely a matter of judgment, the rate being governed by the height to which the sand grains rise, but this should not be high enough to allow sand to overflow into the gutters. The higher rates seem to produce the best results with a minimum quantity of water.

In the beginning a wash, if the rate is high, violent explosive actions occur in the bed due to imprisoned air, which in some cases tear large holes in the sand, rolling the film of mud together, producing mud balls and leaving portions of the bed unbroken. This condition was avoided by first starting the wash at a very low rate, about 3 in. vertical rise per minute, and continuing until all the air is expelled. This method also avoids destructive ram action on the strainer system.

Measurements of the quantity of imprisoned air in a filter bed are now under way; from eight observations made from June 1 to 10, 1917, the average quantity is approximately 380 cu. ft. of free air.

Samples of sand through a vertical section of several beds were collected by driving two 1¼ in. angle irons through the sand to the gravel after draining the bed, so as to inclose a pyramidal section which could be withdrawn and trimmed to a uniform section. These sections were divided into several equal lengths and washed clean in a definite quantity of water, the turbidity of which was proportionate to the quantity of sediment in any vertical section of the bed. It was found that most of the sediment was in and above the top ¼ in. layer of sand and below 6 in. from the top, the amount of sediment in the sand remaining nearly constant during the whole period of filtration and washing.

Some difficulty was experienced by the operators at first in judging the rate at which a filter was being washed. Opening the wash water valve a certain amount did not always give the same quantity each time, due to difference in elevation of the water in the wash-water tanks,and also to the frictional resistance in the bed. This led to the installation of a low friction rotary switch which was operated by the rocker arm of the recording device on the wash-water Venturi meter. This switch controlled a current to three electric lights mounted at the south end of the plant, allowing one lamp, a green one, to light when the rate of wash was between 5,000 and 17,000 G. P. M. and a white lamp to light when the rate was between 16,000 and 20,000 G.P.M. and a red lamp to light when the rate was above 20,000 G. P. M. These lamps can be seen from any operating table in the plant and allows the operator to wash any filter with a variation of not over 5 per cent in the rate of wash. This device has proven very satisfactory and no inaccuracies of the Venturi meter have resulted from it.

The aluminum sulphate used in connection with filtration is bought in bulk, the lump usually being under 2 in. in the greatest dimension; it is shoveled from the cars into an elevator boot where it is elevated to the top floor of the head house, and by means of cross conveyors is dumped into any one of six hopper bins. It is taken from the bins below through vertical chutes emptying into steel weighing buckets running on a trolley. A definite weight is dumped from these buckets into a concrete dissolving box where it is dissolved by a stream of water passing through it into storage tanks below. After dissolving the contents of one dissolving box the tank underneath is filled with water to make a definite percentage solution of the chemical. From these tanks the solution is pumped to orifice boxes at both ends of the filter plant.

In these orifice boxes the level of the solution is maintained at a constant head by pumping a greater quantity than that used, the overflow returning to the storage tanks. The opening of the orifice is varied in size by means of a nearly conical plug. This plug on three of the orifices at the north end is operated by motors controlled by floats in tubes connected to the two 8 ft. Venturi meters, through which the water to be filtered passes, so any ratio of solution to the water to be filtered is maintained automatically through a wide variation in the amount of water passing the 8 ft. meters. The solution from the orifices passes through 4 in. Venturi meters, which record the rate of flow, and is discharged into the water before entering the mixing basin north of the filter plant.

The solution from the land controlled orifice boxes is discharged into the influent flume after passing through recording Venturi meters.

The chlorine is, at present, purchased in steel cylinders containing about 100 lb. of liquid chlorine. The chlorine is measured by four indicating rate-of-flow machines and goes into solution in rubber towers filled with pumice stone by allowing water to trickle down through the tower, the gas discharging into the bottom of the tower. The erosive action of the gas when moist is very great and a lot of time and care is required to maintain in proper condition those metal parts of the machine which come in contact with the gas. Chlorinated oil from the gas requires the rate-of-flow machines to be cleaned about once a week.

The filter plant is heated by three 150 hp. boilers located in the head house. The system used is Webster's vacuum system. There are about 3,200 sq. ft. of cast iron radiators and an average temperature of 68° was maintained in the plant when the outside temperature was 6° below zero.

The average costs for labor, material and general maintenance for the period between June 1, 1915, and April 1, 1916, and the succeeding 12 months are \$2.47 and \$2.05, respectively, per 1,000,000 gal. This cost does not include the lime and iron used in softening and coagulation, but does include the aluminum sulphate and chlorine.

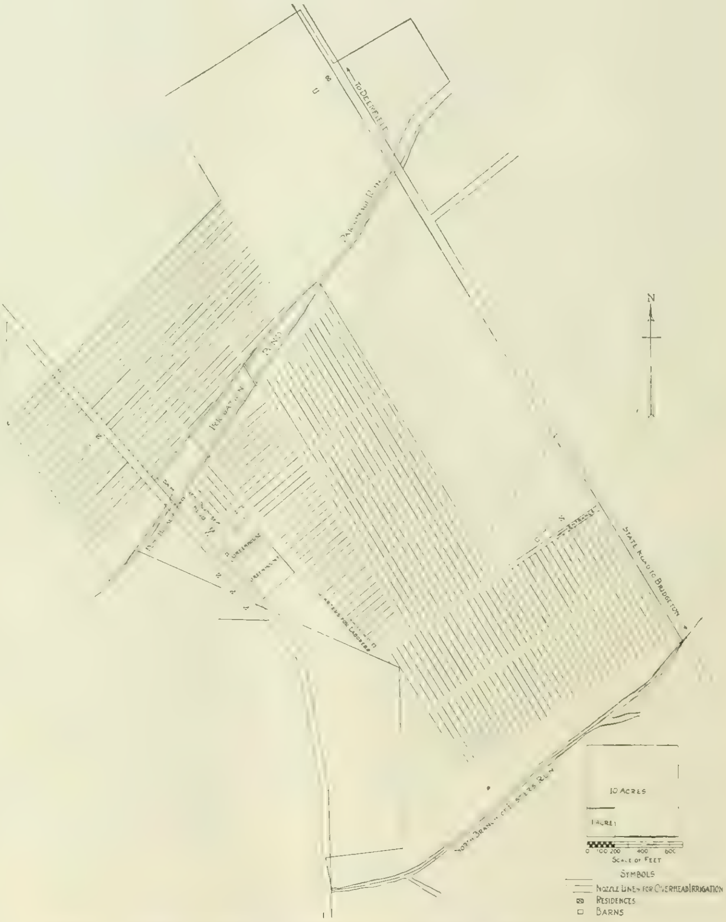
During the year ending April 1, 1916, 1.74 grains of sulphate of iron and 5.57 grains of lime were used per gallon of water pumped into the basins; during the year ending April 1, 1917, 0.72 grains of sulphate of iron and 5.23 grains of lime per gallon were used, making a total cost of purifying the water before adding the aluminum sulphate at the filter plant, for the year ending April 1, 1916, \$4.37 and for the year ending April 1, 1917, \$3.54 per 1,000,000 gal.

A contract has been executed between the Department of the Interior and the Imperial Laguna Canal Co., whereby some 120,000 acres of land adjoining the Imperial Valley in Southern California will be irrigated by a 30 mile canal, the supply being obtained from the Yuma Reclamation Project.

Overhead Irrigation at the Seabrook Farms, New Jersey

The great essentials for successful farming are soil fertility, proper cultivation and moisture. At the Seabrook Farms at Bridgeton, N. J., these three essentials have been so highly developed that in 1916 the gross sales of produce from a total farm area of 600 acres amounted to \$212,000. Five years ago the complete farm consisted of 35 acres and the gross sales totaled \$26,000.

The distinctive feature of the intensive agricultural methods employed at the Seabrook Farms is the employment on a large scale of the Skinner overhead system of irrigation by means of which the vegetation may be subjected at will to a fine mist which saturates the atmosphere above the soil and consequently the soil itself. This system of irrigation on the farm about 5 years ago covered only 15 acres, but it has proven so suitable that the area covered by the overhead piping has been extended each year until it now serves 182 acres, making it the largest installation of the kind in the world. A very interesting



Layout of Overhead Irrigation System of the Seabrook Farms Co., Bridgeton, N. J.

description of the plant and general methods at the Seabrook Farms was given by Mr. Charles F. Seabrook, president of the Seabrook Farms Co., in a recent issue of "New Jersey," a publication of the New Jersey State Chamber of Commerce. An abstract of this article follows:

In growing of irrigated crops there are some very important matters that must be taken into consideration. The building up of the soil, for example, to a high state of fertility and the installation of an irrigation plant involve the investment of considerable capital and as a basis for success one must first be certain of an ample supply of water. This can be obtained from a natural stream, a pond, artesian wells, or a city water service. But, in any case, engineering construction work is involved; and this, with the heavy applications of stable manure and fertilizer, necessitate sufficient resources to permit of conducting such a class of business on a very broad scale.

The investment necessary for such preparation as adopted at the Seabrook Farms as standard for its intensive crops must not be lost sight of. The large returns, however, realized under this method are believed to be chiefly due to the extensive use of manures, the careful preparation of the soil and the presence of moisture when it can be of the most benefit. This flexibility provides for any degree of moisture and for any length of time.

An acre of land as prepared at the Farms represents an investment in labor and fertilizer alone of approximately $600, and when to this must be added the cost of the irrigation piping, which at present values will reach $200 to $225 per acre, it will be appreciated that intensive farming under this plan, while almost certain of results, necessitates considerable outlay. As against this may be appropriately noted the fact that as shown by four successive seasons since this system has been in extensive operation the results actually obtained under commercial conditions, and for the regular crops handled have been about as follows:

Six hundred and forty bushels of potatoes per acre have been grown under irrigation; whereas the average yield without irrigation would be about 175 bushels for the same area. With beets for the cannery where the tops are included in the weight allowed, the yield per acre will be about 32 tons under irrigation, but without irrigation about one-tenth that amount is produced. Six hundred crates against one-third that number per acre is the yield expected from celery under irrigation.

Onions give, perhaps, the most satisfactory increase (with the exception of cabbage and lettuce) of any of the garden crops; 1,200 bushel may be expected with irrigation and 300 bushels without. Big Boston lettuce yields from 40,000 to 50,000 perfect heads to the acre under water. This means a spacing of less than 1 ft. apart each way. Without irrigation, it is seldom possible to get a uniform stand of lettuce and on an acre without the water we figure the yield will be 20,00 to 25,000 heads. Considering both quantity and quality, the yield from a non-irrigated acre will represent a ratio of 1 to 5.

Another advantage, which is perhaps creditable in no small extent to the irrigation feature of the plant, is the increased rate of production from any piece of ground during the growing season. The time taken to grow a particular crop is appreciably less under irrigation than without, and this, of course, permits a more rapid succession of crops.

In illustration of this point, the methods of crop rotation for a period of say 5 years would be, to grow intensive garden truck such as lettuce, cabbage, celery, potatoes and spinach for 2 years, followed with strawberries for 2 years; then 1 year of onions, beets, carrots or other root crops which do not require such heavy applications of manure.

During the period of growing intensive "truck," a typical rotation would be: Spinach planted in March and harvested by early May; early potatoes planted by May 10 to be harvested in time to prepare the land for celery, which would be planted from Aug. 15 to 20. The celery would be intercropped with a two-thirds crop of spinach, or instead of celery we would plant lettuce Aug. 15 to 20, which would be off the land in time to plant a full crop of spinach between Sept. 25 and Oct. 1. This latter plan it will be noted gives four full crops from the same land in one growing season.

As one will readily imagine an almost endless number of combinations of the various crops and their order of planting may be worked out in a way that will prove convenient and insure the right crop maturing at the right time for the best market returns.

As a concrete example of the way such a typical intensive rotation may result when figured in dollars and cents over a period of say three years, the following actual returns received during the years 1914, 1915 and 1916 from a certain portion of the farm, may be of interest.

Spinach was planted about the last of February or first of March; this crop, which requires only 4 weeks to mature in the fall, takes from 5 to 6 weeks in the spring. It was, therefore, about April 15 when this first crop was marketed in 1914, and the yield ran somewhere between $100 and $150 per acre. By May 10 the yield was cleared and planted to potatoes, which were harvested Aug. 10. The yield in this instance gave an average figure of 640 bu. of potatoes grown under irrigation. These potatoes brought 70 ct. per bushel, or very nearly $450 per acre.

Immediately after the potatoes were harvested, in fact the same day, the succeeding operations of the crop rotation followed without the loss of an instant of time; the same field was planted out in strawberries and inter-cropped with Romaine, to be cut in October. The yield from the latter was about $500 per acre, making a total yield per acre for that season of approximately $1,100.

The second year the strawberries were harvested and they yielded what is termed a half crop, as this is all a fall planted strawberry crop can be expected to supply the first spring following. The value of the crop was $600 per acre. To give the strawberries proper cultivation and care for their full yield in the spring of the second year after planting, which would be the third year of this rotation, the necessary attention was given to the crop, but no additional crops were attempted from this land during that second year.

The berry plants showed the benefit of this treatment and yielded, the following spring, a crop having a cash value of $1,300 per acre. Following this harvest the plants were plowed under and the field was planted out in lettuce, followed by spinach, which latter was ready for the market in October. The spinach brought $150 per acre and the lettuce about $1,000, making a total yield for that year of $2,450 per acre of ground, or a total for the 3-year rotation of approximately $4,150, which averages better than $1,380 per acre per year.

The engineering features of equipment on the Seabrook Farms have undergone an evolution quite similar to that which has obtained in developing the agricultural side of the production problem. At the start the water supply consisted of an artesian well which cost about $100. It was merely an iron pipe driven into the ground about 55 ft. To this pipe was coupled, through one suction, two 5-in. by 5-in. pumps each capable of delivering its water at a pressure equal to a head of from 100 to 150 ft. These two pumps cost $100, and one was intended to relieve the other as a spare. In addition, there was a kerosene oil engine, the cost of which was about $300.

From this the pumping plant has grown to its present capacity of 3,600 gal., from three pumping units fed from a reservoir covering five acres. In fact, at the present time the company is preparing to double its water resources to properly provide for its increasing needs. It is contemplated, however, that the increased demand for water distribution will require the adoption of a more flexible arrangement of pumping facilities such as would obtain if all the pumping units were electrically operated and located at the several logical centers of distribution rather than at one central point.

The rates charged at present for electric power current range from 3 ct. per kilowatt hour maximum to 1¼ ct. minimum, on which latter basis the electric current is cheaper to use for pumping than is the internal combustion engine.

The rates for current being reasonable, it is probable that even with increasing growth of this power operated installation current will be purchased from the service company rather than generated on the farm. This, it is believed, will prove more economical, since the largest amount of water is required for the extensive field areas now under irrigation, and this power demand is substantially more at certain seasons of the year than others. This is true even though water is liberally used in the greenhouses to force the early spring, fall and winter crops. The pumping, therefore, cannot be regarded as uniform in its characteristics on account of the constantly varying weather and crop conditions. This circumstance makes the possibilities of a central generating plant for the supply of such pumping current unattractive, as the equipment necessary for maximum demand would necessarily remain idle through a large percentage of the total time.

With the present equipment there are available one 70-H.P. kerosene engine pumping unit, one 50-H.P. electric motor-driven pump, and one outfit that may be driven by a 20-H.P. tractor. The maximum demand for pumping power now being 100 H.P., it will be seen that to meet this condition properly it is necessary to operate at least the two larger units if not the entire three, as it is essential to have ample pumping capacity behind the water to overcome pipe friction losses, forcing the spray against wind pressure or other difficulty that may require power to over-balance. As a general thing the watering of the crops can be so accomplished as to suffer the least possible inconvenience from wind pressure, as the local lengths of distribution pipes may be rotated on their supporting posts so as to let the spray float along with the wind, insuring the minimum demand for pumping power for a given quantity of water applied.

A greater number of pumping centers of smaller size it is believed would simplify the general piping scheme and reduce pipe friction, or to put it in another way, necessitate smaller sizes of pipes for a given loss in transmission of the water from its source to its destination. By adopting individual motor driven units the flexibility of such a plan becomes a maximum. This plan should reduce the cost of the general piping system and the constant cost of the power for pumping, which under the present conditions has been determined to be about 0.6 H.P. per acre for proper irrigation under normal circumstances.

The piping system has gone through quite an evolution, improving each time extensions were made; the fundamental aim always being to so proportion the sizes and arrange the runs so that there may be as little pipe line resistance to the water flow as possible, and at the same time not involve excessive investment through the selection of unnecessarily large pipe sizes. To insure observance of this important factor the new extensions are planned on a unit basis which will make possible the most economical equipment suitable for the purpose. This is very important, since the piping system, especially at prevailing prices, necessitates a large capital investment and to secure the greatest return, this item must be figured with care.

With the present plan the main supply pipe from the pumping plant to the nearest distributing center consists of 8-in. pipe and is about 1,000 ft. in length. From this point the sub-mains are of 6-in. pipe and vary from 2,000 to 3,000 ft. in length and no feeder pipe is of less than 4 in. in diameter. All of the feeder pipes are laid underground and although below the frost line they are so installed as to be self-draining when the water supply is shut off for the winter season. To appreciate the extent of this heavy piping system it should be noted that the water has to be pumped over a mile to reach the fields to be irrigated at some portions of the farm. A system of "bridging," however, has been adopted whenever possible so that the water may have two parallel avenues of travel through relatively smaller pipes than would be necessary, but each of which has to be installed in any case to reach the several fields laid out as they are in different directions.

The distribution piping is entirely overhead and is supported on sawed chestnut posts cut 9 ft. long, measuring 2½ in. by 4 in. at the top and 4 in. by 5 in. at the butt. These posts are treated with creosote and set in the ground from 2½ ft. to 3 ft. The pipe sizes for the distribution runs range from ¾ in. to 2 in. in diameter and from 300 ft. to 600 ft. in length.

The average garden plot, according to the standards now used, measures 50 ft. by 600 ft., and as the irrigation piping is spaced 50 ft. apart the unit lengths and sizes of pipe employed to make the run of the long measurement of the plot has been determined as follows: 100 ft. of 2-in., 175 ft. of 1½-in., 175 ft. of 1¼-in., 160 ft. of 1-in. and 90 ft. of ¾ in.

As to the quantity of water necessary to apply, this varies largely according to the crop, the condition of the ground and the weather or season. Those experienced in irrigation also differ somewhat in their opinion as to this factor. It is fair to say, however, that this difference of opinion is doubtless accounted for by the soil conditions which vary in all localities and naturally anyone's opinion would lean in the direction which is governed by the conditions with which he is most familiar.

The Seabrook Farms' practice is to make liberal applications of manure and use plenty of water when the crops will stand it, but, of course, care has to be constantly exercised in a matter of this kind. In building up poor or new land, 100 tons per acre of stable manure in one season have sometimes been used. This may be applied either in one application which would be about 4 in. thick, or in, say, two applications of half the quantity, one early and one later in the season. The standard application to ground on which the fast growing crops are to be raised is from 2 to 2¼ in. and averages 60 tons to the acre.

With the soil enriched in this way the amount of water which experience has shown to be advantageous to apply will run from 12 to 20 in. in a growing season. This, of course, is in addition to the regular rainfall which at Bridgeton has for the past ten years averaged approximately 25 in.

The maximum application will run considerably over the irrigation requirement for an average crop. Some of the rapid growing crops can be greatly forced under an abundance of water and in a heavily fertilized soil. Parsley and cabbage, for example, will take a very large amount of water if the season is dry. Cabbage may be watered in dry weather each day over a period of two weeks and will utilize to advantage, perhaps, 10 in. of water in that period. The maximum quantity of water and rate of application at any one wetting for most crops will be 1 in. in 12 consecutive hours.

In addition to the other farm operations the company engaged in the growing of greenhouse vegetables on an extensive scale, and this forms a very important part of its business. It is a branch which enables it to utilize a considerable amount of labor during the winter months when the weather is unfit to work out of doors. By this means it is able to keep a number of men the year through where they would otherwise have to lay them off during the winter with a strong possibility of losing their services permanently. The greenhouses also provide an income at a season when there is not a great deal to sell in the way of outdoor crops.

The houses are devoted to the growing of cucumbers, tomatoes and radishes. These are planted so that the cucumbers and tomato crops will be at their height during the holiday season and again in the spring so that these crops may be harvested several weeks before the same kind of vegetables mature in the fields. During the time between such crops the greenhouses are planted in radishes. Over 6,000 dozen cucumbers were recently gathered from a single crop in one of these houses and the receipts from the crop amounted to approximately $2,300. The receipts from one crop of radishes in one house alone was $1,600. This crop was entirely marketed within eight weeks from the time of sewing the seed.

A special feature of this branch of the business, and one which is really indispensable, is that of forcing plants for the field crops. The seed is planted in the greenhouse and the plants as soon as large enough are spotted out in flats and later transferred to the cold frame beds where they are hardened and made ready for transplanting to the field as soon as the weather permits. It is needless to mention that the surplus plants thus grown and which are not needed for use on the farm provide a profitable revenue with practically no accompanying cost.

Second Notice to Delinquent Consumers Reduces Cutoffs

By sending out second notices of water bills the water works department of Dallas, Tex., has reduced materially the number of cut-offs for failure to make payments. The system is described as follows by Mr. A. C. Cason, Water Works and Sewerage Commissioner:

"Upon completely metering the city, which is now 100 per cent metered, instead of having the water bills become due on the first of each month, we divided the city up into six districts and allow one district to be due on the first, the next on the fith, the next on the tenth, etc. We were in the habit of mailing out a notice so that they would get it on the day it was due or sooner and then allow 10 days after date before we cut them off, and if the water bill was paid before the expiration of the 10 days we would allow a 10 per cent discount.

"Each one of these districts had between 4,000 and 5,000 accounts, and under the old system of one notice we would cut off from 300 to 500 customers each month in each district. It occurred to us this was an unnecessary expense and trouble to the Department, besides an inconvenience to the careless consumers. We decided we would evolve some manner of giving a second notice. We finally decided that a few days before the expiration of the time we would mail out a second notice, a copy of which I am enclosing, calling their attention to the fact. We were led to this course not only because we believed it would lighten the work of the Department and also be beneficial to the consumers, but we also considered the fact that the gas, electric light and telephone companies, who were privately owned utilities, gave a second notice, and because the Water Department was a municipally owned utility I did not feel that we were justified in arrogating to ourselves a mode of procedure which was not practiced by utilities which were privately owned.

> FINAL NOTICE.
>
> Your water rent is delinquent and past due.
>
> We will, in accordance with the City Ordinances, be compelled to discontinue service if not paid on or before ....
>
> Prompt payment will avoid inconvenience to you and enable us to render efficient service.
>
> Your co-operation in this respect will be appreciated.
>
> M. C. MANN,
> Secretary and Collector, Dallas City Water Works.

Second Notice for Warning Delinquent Water Consumers.

"I find that there is a feeling among the people that where cities own their own utilities they are inclined to be more dictatorial and exacting than when otherwise owned. I do not think that any little change made in my department during my administration has enjoyed more favorable comment than this one. The system is just beginning to get in good working order, and the greatest number of cut-offs we have had in any one district since this new system has been installed has been about 150, as compared to 450 to 550 heretofore. In one very large district last month where the cutoffs had been from 300 to 500, owing to conditions in the months, the number of cut-offs in this district last month was 36 and in another equally as large there were only 28.

"I feel that this departure has not only been worth while, from the Department's standpoint, but it has had much to do with bringing the consumers and the

Department into closer touch and a more harmonious feeling than ever existed before. To illustrate this point—in two districts, which are composed of the Ninth Ward, known as Oak Cliff, we furnish them with artesian water; the supply from these wells is only about 2,000,000 gal. per day and the normal use is only 1,500,000 gal. per day. When the drought struck us in July, during the sprinkling hours the water was exhausted faster than the wells could furnish it for a few hours each day. I wrote immediately a letter to each consumer in Oak Cliff stating the condition and dividing the ward in two districts, asking one district to stop sprinkling at 6 p. m. and the other to begin at 6 p. m., and for neither district to infringe upon the other's hours. Immediately upon receipt of this letter the co-operation was so general that the trouble was relieved in one day, and we have had plenty of water in this district for all emergencies. I mention this to show the hearty co-operation between the Department and the people at this time, which has not always so existed, and I feel a good deal of this condition is owing to the disposition on the part of the Department to run the affairs of the Department in the interest of the people and not to assume a disposition to oppress the people because the Department had the power."

Method of Laying Submerged Gas Main in Winter

During the past winter the Sheboygan Gas Light Co. laid a gas pipe line across the Fox River at Green Bay, Wis. Steel pipe, 6 in. in diameter and weighing 19.36 lb. per foot was used. The pipe was put together and lowered through the ice. The methods employed were described by Mr. A. F. Davey, Sheboygan, Wis., manager of the Sheboygan Gas Light Co., in a paper presented at the 16th annual convention of the Wisconsin Gas Association. The following matter is taken from Mr. Davey's paper:

The pipe was to be connected up with river sleeves. This is a dresser sleeve threaded on the inside with gaskets at each end and twelve ¾-in. bolts, six on each side, to draw the gaskets up tight. There is no expansion in these joints. Each of these sleeves weighs 140 lb. The rubber gaskets, of triangular cross section, were duck tipped.

On the 6th of January, two expert sawyers, an ice plow, saws and ice picks, were obtained from the ice company. The course selected for the main was close to the bridge and a channel was cut for taking soundings. The plow was used for marking out the trench on the ice. Two or three cuts were made with this plow, 15 in. apart. A horse was used for drawing the plow to a point near the channel where the ice was only 6 in. in thickness, where it was thought best not to use it. Two sawyers, one on each side of the trench, were used to cut the ice after it was marked out by the plow. A man with an ice pick followed them along, breaking the sawed ice into 3-ft. lengths and pushing them under the ice out of the way. Three men with a sounding bar followed the sawyers, taking soundings every 2 ft. The rod, or sounding bar, was marked off into feet and quarter feet, and was made from 1¼-in. pipe. One man followed the sounders, keeping the records.

The river bed was found to have a natural slope from each side toward the channel, at which point it was 30 ft. deep. The work of sounding took about eight hours, being finished at 4 o'clock.

At 2 o'clock in the afternoon, after three-quarters of the work of sounding had been completed, the wind came up and blew across the river at the rate of 36 miles per hour. The temperature dropped from 8° above to 6° below. After the work of sounding had been done, steps had to be taken to protect the skaters and men from the coal docks who walked across the river, from the trench. A great many limbs cut from trees around the city by the electric department, that were piled near the gas works, were hauled to the job and placed in small holes made in the ice on the side of the trench about 5 ft. apart. These, with lanterns hung every 5 ft., were very effective. It was found out afterwards this was unnecessary, as at 6 o'clock the ice on the channel had frozen enough to walk upon.

The pipe had been painted three coats of pipe paint applied hot and had been piled up at the gas works. The pipe was hauled to the river bank on sleighs and placed upon an improvised sled made of 4x4's and one horse was used to draw it out in place, ready for being screwed together.

The pipe, after being hauled out onto the ice, was placed directly over the trench where the soundings were taken and screwed together, six men being used for this work: one man on the tongs and the other five men pulling on the rope fastened to the tongs in order to draw the pipes up to the last thread. After two pipes were connected, one man followed them putting in bolts and drawing them up. After the joints were tight, they were carefully gone over again with pipe paint.

All the pipe was screwed together on top of the ice and tested under 20 lb. of gas pressure. Two slight leaks in sleeves were found and repaired. The main was then tested again and found tight.

The drip was installed over the low spot in the river which had been found when sounding. The 6-in. service clamp was placed onto the main with a lead gasket. The service clamp had a 1½-in. opening into which a 1½-in. street ell was inserted and the drip pipe extended about 100 ft. east and 80 ft. south to the nearest bridge pier.

It was decided to start the work on Sunday morning and use yard men and drivers regularly employed at the gas works. Four double blocks and tackle were borrowed from the electric department and placed around the pipe and fastened to the bridge. A sawyer on each side of the pipe cut out the trench. Another man followed them along, pushing the ice out of the way. After 100 ft. of trench had been opened, that much pipe was lowered into the river, the blocks being moved from time to time. At noon, after a bad start, about 150 ft. of pipe had been lowered. After dinner, work went along in good shape.

On Monday morning, the work of lowering the remaining main and drip began. The drip was fastened to the main by strong wires and all lowered at the same time. Monday afternoon, at about 5 o'clock, the entire main was in place in the river. Early the next day a test was made. A sand hole in one of the fittings used on the drip was found, and therefore repairs were made without interfering with the main. A 30-lb. test was put on the main at that time and found to hold for four hours with only a very small loss in pressure. Nothing further was done with this main until in April when the ice was all out of the river.

The cost of laying the river main was 15.5 ct. per foot. The cost of patrolling and repairing the leaks by a diver brought this up to 27.5 ct. per foot.

A Page from Recent Waterworks Reports

Stratification of Aluminate Sulphate Solutions.—Specific gravity determinations of the strength of the aluminum sulphate solutions as discharged from the orifice boxes at the north end of the Chain of Rocks filter plant of St. Louis, Mo., were made last year, to see whether or not this solution on standing in the tanks has a tendency to stratify. In the preparation of the solution, water is allowed to flow over a weighed quantity of dry crystals in dissolving boxes and after solution has been effected fresh water is added to make it up to the desired strength. This is then agitated for about 20 minutes by a propeller on the end of a motor operated vertical shaft. The solution which may stand in the tank for a period of from 24 to 72 hours, depending on the rate of use, is then drawn from the tank through an opening near the bottom. The samples for the gravity determinations were collected at the outlet when the solution in the tank was at various depths. The table below shows that the strength of the solution as prepared is very close to that intended and that if stratification does occur on standing it does not appreciably alter the strength during the period of use.

Depth of solution in tank at time of sampling at outlet.	Solution strength, per cent. (Intended, 1 per cent.)	Depth of solution in tank at time of sampling at outlet.	Solution strength, per cent. (Intended, 3 per cent.)
9.5 ft.	1,0711	10 ft.	2.9676
7.1 ft.	1.0711	9 ft.	2.9862
5.9 ft.	1.0587	8 ft.	2.9709
2.7 ft.	1.0566	7 ft.	2.9280
0.6 ft.	1.0612	6 ft.	2.9247
		5 ft.	2.9091
		4 ft.	2.9058
		3 ft.	2.8884
		1.8 ft.	2.8978
		0.5 ft.	2.8851

Effect of Sanitary Improvements on Death Rates.—The effect on the death rate of the installation of sewers, drainage systems and a new water supply at New Orleans, La., is shown by the accompanying table. The population of the city in 1881 was 219,000 and in 1916 it was 378,000. The increase from 1900 to last year was at the rate of 5,000 to 7,000 per year.

EFFECT OF SANITARY IMPROVEMENTS AT NEW ORLEANS, LA., ON DEATH RATES.

Year.	Number of premises at end of year connected with The sewers.	Number of premises at end of year connected with The new water supply.	Miles of sanitary sewers in place.	Miles of water mains. M. G. D. consumption.	Main drainage system. Acres area drained.	Miles of lateral storm drains, 10 to 30-in.	Death rate per 1,000 per annum from all causes Average.	Deaths per 100,000 per annum. From malaria. Average.	Deaths per 100,000 per annum. From typhoid. Average.
1881-1890	......	......	...	...	....	...	28.6	156	21
1891-1900	......	......	...	...	.....	...	27.2	104	39
1900	......	......	...	...	.	...	25.9	68	40
1901	......	......	...	...	20,000	...	22.2	40	48
1902	......	......	...	...	21,000	...	22.1	33	45
1903	......	......	‡...	...	21,000	...	22.2	27	38
1904	......	......	115	...	21,000	...	22.2	22	36
1905	......	......	160	§...	22,000	...	23.5	15	32
1906	*.....	......	224	35	22,000	...	21.4	13	30
1907	325	......	273	160	22,000	...	23.6	12	57
1908	3,400	*2,000	302	485	22,000	75	22.4	20	53
1909	9,000	**15,800	322	508	22,000	132	20.3	13	29
1910	13,800	26,000	353	512	22,000	154	21.4	9	32
1911	20,200	36,000	393	518-15.7	22,000	170	20.4	9	31
1912	28,500	46,000	426	530-16.6	22,000	151	20.1	8	14
1913	42,000	55,000	462	547-19.2	23,000	190	19.8	6	17
1914	58,000	64,000	477	565-22.7	24,000	233	20.3	9	21
1915	67,000	70,000	486	581-25.1	25,000	265	20.8	9	21
1916	72,000	73,000	496	591-27.8	25,000	293	18.1	7	23

*Started to connect. †Started. **Filtered. ††Started building sewers. §Started laying water mains. Started operating

Cost of Operating Collection Department of Water Works.—The Collection Department of the Sewerage and Water Board of New Orleans, La., handles all individual accounts and collections, reads all meters, writes and delivers bills, inspects water piping and fixtures in private premises where bills appear to be excessive; and maintains a complaint and information branch, where men are on duty day and night to receive and give attention to complaints, and to answer inquiries regarding all departments of the Board; and to report accidents to proper departments that they may receive prompt attention. During the year 1916 the department handled collections totaling $708,357. The comparative costs of operating the department during the years 1915 was as follows:

	1915. No. of accounts, 51,319. Expense per account.	1916. No. of accounts, 53,700. Expense per account.
Applications, complaints and information	$0.16	$0.15
Opening and closing	.10	.10
Meter reading and inspecting	.28	.27
Accounting	.28	.27
Billing	.23	.22
Collecting	.17	.16
Totals for collection department proper	$1.22	$1.17

Operating Expenditures of Milwaukee Water Works.—The following tabulation from the 1916 report of H. P. Bolemann, Superintendent of Water Works, Milwaukee, Wis., gives a summary of the operating expenditures for 1916 per 1,000,000 gal. pumped:

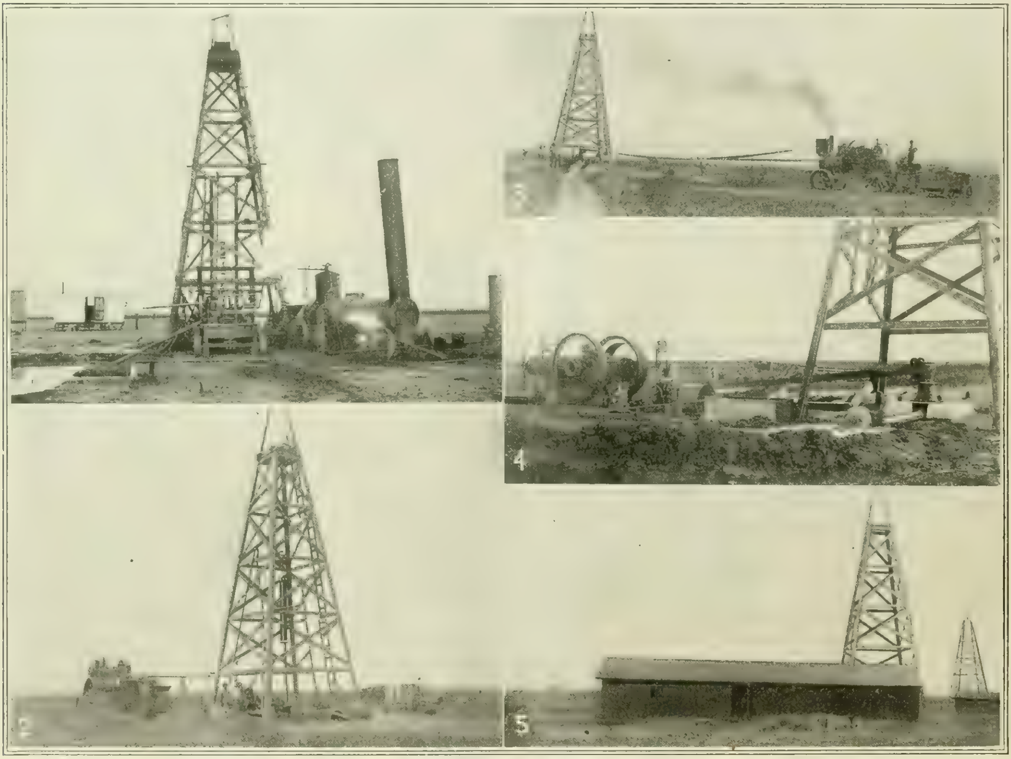
Classification.	Items.	Per million gals. pumped.
General office expense	$ 15,556.33	$ 0.774
Miscellaneous general expense	2,532.06	125
Commercial expense	57,979.36	2.886
General stores expense	3,824.60	.190
Water collection properties	....	....
Purification	6,710.90	.334
Pumping (North Point pumping station)	113,732.69	5.662
Pumping (Riverside pumping station)	40.84	.002
Repumping (North Ave. and Tenth St. station)	15,059.06	.749
Transmission mains, reservoirs and standpipes	3,654.17	.182
Distribution division	50,794.64	2.528
Meter division	27,142.05	1.351
	$297,026.70	$14.783
Depreciation	96,296.00	4.794
	$393,322.70	$19.577
Financial expenditures	7,212.39	.359
Total	$400,535.09	$19.936

Water Consumption and Waste at Waltham, Mass.—The average daily consumption of water at Waltham, Mass., during 1916 was 71.2 gal. per capita. The maximum reported was 95 gal. in 1912 when metering was undertaken in serious earnest. That the waste has been reduced since, is shown by the following table of average per capita rate of use or waste between the hours of 1 a. m. and 4 a. m.

Year.	Per cent of services metered.	Per capita per day.
1912	18½	61.3
1913	25	62.0
1914	34	51.0
1915	43	45.3
1916	53	43.7

Large Capacity Deep Well Irrigation Pumping Installation in Texas Panhandle

During the last few years many thousand acres of land in the Panhandle of Texas have been placed under irrigation. The supply is obtained from deep wells by means of pumping plants, and is distributed to the fields through ditches. The first large capacity deep well irrigation pumping plant in this territory was installed in 1910 by Mr. D. L. McDonald of Hereford, Tex. Since that time he has drilled and developed over 50 large capacity wells in this area and installed the pumping machinery complete. The accompanying illustration shows the various stages of one of these installations.



Operations for Developing a 1,500 Gal. per Minute Irrigation Supply from Deep Well.

(1) Drilling well. (2) Installing pump. (3) Developing well by pumping out sand (50 carloads of sand were taken out of this well). (4) Permanent engine installed and well discharging 1,500 gal. per minute. (5) Installation housed and completed, derrick left standing for use in making repairs or changes.

The equipment for this plant consists of a 24-in. American pitless deep well turbine centrifugal pump driven by a Bessemer oil engine. All machinery is installed on good concrete foundations, which is very important. The belt centers are 30 ft. The lubrication over the entire plant is mechanical. The engine lubricator is ordered with two extra connections over the requirements of the engine and run to the pump. One is for the roller bearing in the pulley and the other to oil the shaft. This feature insures proper lubrication and removes all oil adjustments so that the farmer has nothing to do but keep the lubricator filled with oil.

Cooling water for the engine is taken from the discharge pipe of the pump. The circulating water is discharged back into the cooling tank with an overflow into the ditch. This system is very simple and positive and heads off all danger of overheating the engine in case the belt laces should happen to break with the operator perhaps out in the field a mile away. The cooling tank has a capacity of 400 gal. The fuel oil tank for the engine is placed ahead of the engine on top of the ground. This avoids the use of check valves which has been found by experience to be troublesome. This system allows the oil to flow to fuel pump by gravity. Oil from the big tank is pumped into the small auxiliary tank, elevated above the large ground tank. This also avoids the use of a check valve and feeds the engine by gravity. Another feature of this arrangement is that the fuel pump is driven from a pulley on the end of the circulating pump shaft and any time the circulating pump is not working the fuel pump stops. In case the circulating pump belt breaks the fuel pumps stop and the engine stops automatically in 3 or 4 minutes which avoids overheating.

San Francisco, Cal., is calling for bids for construction of a water supply tunnel to cost $6,000,000.

Cost of Chemicals for Chain of Rocks Filter Plant

Some interesting data on the cost of chemicals used at the Chain of Rocks filtration plant of St. Louis, Mo., are given by Mr. August V. Graf, Chemist in charge of purification work, in the anual report of Edward S. Wall, Water Commissioner of St. Louis, for the year ending April 1, 1917. Extracts from this report follow:

During the past year, 37,296,000 gal. of water were pumped into the basins. To this amount of water were added 1910 tons of sulphate of iron and 15,924 tons of lime, or an average of 0.72 grain per gallon of the former chemical and 5.23 grains per gallon of the latter.

To the 36,815,000 gal. of water filtered were added 1573.5 tons of sulphate of alumina and 49,080 lb. of chlorine, or an average of 0.70 grain per gallon of the sulphate and 1.33 lb. per 1,000,000 gal. of the chlorine. The aluminum sulphate was added before filtration and the chlorine after.

The yearly maxima, minima and average of the sulphate of iron and lime used in grains per gallon since the installation of the process and the total quantities of lime and sulphate of iron used during the same period have been as follows:

The average cost per 1,000,000 gal. for lime was $1.74, for sulphate of iron $0.59, for sulphate of alumina $0.78 and for chlorine $0.14. These costs are for chemicals alone and do not include the cost of handling or application. A comparison of the costs of the various parts of the purification work during the past five years, based on the quantity of water delivered to consumers, is shown in Table I:

The amount of sulphate of iron used per gallon during the past year was less than half the amount used during the previous year. The amounts of lime, sulphate of alumina and chlorine are also less. The decrease in the amounts of chemicals used was more than great enough to offset the increase in price of the chemicals.

TABLE I.—COST PER 1,000,000 GAL., BASED ON CONSUMPTION.

Old Plant—	1912-1913.	1913-1914.	1914-1915.	1915-1916.	Nov., 1915, to Apr., 1916.	1916-1917.
Lime	$1.73	$1.87	$1.61	$1.70	$1.61	$1.89
Iron	2.42	1.92	2.02	1.42	.64	.61
Unloading	.12	.11	.10	.08	.07	.08
Op'ating, maintenance and repairs	.44	.42	.35	.47	.51	.38
Water, coal, oil, etc.	.05	.05	.04	.03	.04	.03
Light and power	.05	.04	.03	.07	.07	.04
Chemical work	.29	.28	.27	.43	.49	.38
Basin cleaning	.10	.07	.12	.14	.08	.12*
Basin repairs	.10	.07	.12	.03	.03	.01
Total, old plant	$5.19	$4.80	$4.56	$4.37	$3.54	$3.54
Filters—						
Aluminum sulphate	.....	.....	.....	$0.76	$1.00	$0.79
Chlorine	.....	.....	.....	.18	.15	.14
Op'ating, maintenance and repairs	.....	.....	.....	.83	.98	.80
Coal, miscel. supplies and expenses	.....	.....	.....	.11	.26	.20†
Light and power	.....	.....	.....	.14	.15	.11
Total	.....	.....	.....	$6.42	$6.08	$5.58
Total consumption for year in millioin gal.	29,956	30,927	33,971	32,583	18,138	35,633
Cost of Chemicals—						
Lime, per ton, average 2 contracts	$....	$4.61	$3.18	$3.65	.....	$4.49
Sulphate of iron, per ton	10.00	10.00	10.00	10.00	.....	12.50
Sulphate of aluminum, per ton	.....	.....	.....	.....	.....	21.00
Chlorine, per lb.	.....	.10	.10	.08	.....	.13⅜

*Water used in basin-cleaning included 1916-1917. Omitted other years.

†Water used in filter plant operation included 1916-17. Omitted other years.

The complete purification system was not in use until October 11, 1915. The heading November, 1915-April, 1916, is included to show the costs of purification after the system was completed. These figures are included for the year 1915-1916.

Under the head of lime, iron, sulphate of alumina and chlorine are included all charges connected with the switching of these materials from the interchange tracks at Bissell's Point and Humboldt avenue to the Chain of Rocks.

The sulphate of iron, in the form of sugar sulphate, was furnished by the American Steel & Wire Co. at a price of $10 per ton until July, after which the price was $12.50. The price per ton had been $10 since May, 1907.

Liquid chlorine, at a price of 8 ct. before Aug. 1, 1916, and 13⅜ ct. a pound after that date, was supplied by the Electro Bleaching Gas Co. The chlorine was delivered in cylinders containing 100 lb. of liquid.

Sulphate of alumina was purchased under the same specifications as last year. Basic sulphate of alumina containing not less than 17 per cent of available water soluble alumina Al_2O_3, was required. It was furnished by the General Chemical Co. at a price of $16.80 per ton until Sept. 1, 1916, and $21 a ton after that date.

The lime was furnished under two contracts, each calling for a maximum of 8,000 tons delivered in quantities not exceeding 200 tons per week. The specifications require a lime containing 85 per cent CaO. A bonus of 1½ per cent of the contract price is given for each 1 per cent of CaO above the required 85, and penalties are assessed for each 1 per cent of CaO less than the required 85, in accordance with the sliding scale given below:

	Per cent.
Less than 85% CaO and 80% or more	1½
Less than 80% CaO and 75% or more	2
Less than 75% CaO and 70% or more	3
Less than 70% CaO	5

No payment is made for lime containing less than 65 per cent CaO. All lime was sampled as it came from the crushers after unloading.

The following is the method in use in the laboratory for the determinations of the water soluble calcium oxide in the quick lime furnished us. Approximately 7 grams of lime, contained in a weighing bottle, are dumped into a liter flask containing 500 c. c. of a sugar solution (160 grams per liter). Caking is prevented by causing a whirling of the solution while the sample is being added. The flask is then put on a Camp shaking machine and shaken for 30 minutes. It is then made up to the 1,000 c. c. mark with carbon dioxide free distilled water, shaken by hand and allowed to stand over night. Twenty cubic centimeters of this solution are then titrated with tenth normal hydrochloric acid, using phenolphthalein as the indicator, and the per cent of lime determined. The addition of acid is continued until the first disappearance of the pink color. The color reappears in a short time, but the first disappearance is taken as the end point.

The Glencoe Lime & Cement Co., at $4.50 a ton, and the Mississippi Sand Co., at $4.48 a ton, hold the contracts for the year ending July 1, 1917. The average price paid per ton on all deliveries since July from the former has been $4.64, from the latter $4.04, from both $4.32; the average per cent of lime, CaO present being 84.3. During a similar period last year the average price paid per ton was $3.65, the average per cent of lime being 84.1. The contract prices were $3.84 and $3.68 per ton on two requisitions of 6,000 tons each.

Tests were made to determine the effect of limes of varying percentages of CaO upon the amount of lime that could be slaked before the slaking tank had to be taken out of service. Seven tests were made and the results showed that for every increase of 1 per cent in the available CaO, above the lowest lime tested, an additional 10 tons could be slaked.

Purification of Tannery Wastes

For some time the government has been studying methods of purifying industrial wastes from plants that were representative of different industries in producing liquid wastes. Testing stations have been operated at tanneries at Luray, Va., and at Cincinnati, O. As a result a large amount of valuable information has been obtained on the purification of tannery wastes. The results of those tests are outlined by Mr. H. B. Homman, Sanitary Chemist in charge of field work, in the July Journal of the American Leather Chemists' Association, from which the matter following has been abstracted:

Testing Station at Luray, Va.

The Deford Co. make butts for belting leather from cattle hides and sole leather from the heads and bellies. Tan liquor leached from oak bark at the plant is used in tanning the butts and some chestnut extract for tanning the heads and bellies. No other chemicals are used except a small amount of alkali and acid in bleaching the heads and bellies. There is no bating and the liming process is the ordinary procedure of most all tanneries. The unhairing is done entirely by machinery and the fleshing almost entirely by machines.

The favorable situation of the outlets from the Deford tannery whereby a gravity flow through the test units could be obtained and the interest taken in the work by the owners of the tannery were the factors that determined the location of the testing station at Luray. Every process in the tannery producing liquid wastes had a separate accessible outlet and advantage was taken of this favorable situation to study each waste separately at first and later to bring them all together in the proportion in which they were discharged from the tannery.

Settling tanks and filters were installed on each of the four principal outlets in the early part of the tests and the volume from each outlet and the effect of the treatment studied for one year. The wastes from each outlet may be described as follows: First, those from the beam house, including the spent lime waters, washings from the beam house floors and the alkali and acid waters from the bleaching vats. This waste computed on a basis of flow through the entire tests was 65,500 gal. per day. Second, the water used in washing the lime out of the hair removed by the unhairing machine. This was 23,500 gal. per day. Third, the spent tan liquors from the rocker pits and the wash water resulting from rinsing the hides when removed from the lay-away yard. These wastes were, in volume, 7,000 gal. from the rocker pits and 7,000 gal. from the hide washing. Fourth, a small amount of dilute liquor from a revolving drum in which the heads were rinsed, and the water wrung out of the heads and bellies by centrifugal machine after bleaching.

The Government is interested not only in developing methods of purification, but in assisting the manufacturers in saving material escaping in their liquid wastes and making actual demonstration of the fertilizing value of the solids removed by the settling tanks. Therefore, during the early part of the tests each waste was studied separately but later when the volume and chemical composition of each had been determined a portion of each one was delivered to a central point where the principal devices were located and the tests continued by mixing the different components and treating them in various combinations of settling tanks and filters.

The early studies had proven that the spent tan liquors were too concentrated to permit of purification by filters operated at economical rates, and it was necessary to utilize the reaction between the tannic acid and the excess lime in the beam house and hair washing wastes to obtain a mixture that would be suitable for treatment on filters. Even this combination, however, required rates of filtration too slow to be practical for a permanent plant. Further studies at this time developed the fact that by treating the spent tan with sludge from the lime vats its concentration could be reduced about one-half, and the strength of the combined beam house and hair washing wastes could be considerably reduced by treatment with iron (copperas or ferrous sulphate) at the rate of 10 grains per gallon. The combination of these wastes thus modified admitted of purification in a plant that will be within the financial limits of the average tannery.

The plant that was operated during the latter part of the tests included the following tanks and filters: First, a storage tank for the spent tan liquor, 7 ft. by 8 ft. in plan and 2 ft. deep. In this tank the spent tan was treated with lime sludge, the mixture allowed to settle and the supernatant added to the beam house and hair washing wastes. Second, a small storage tank of about 10 cu. ft. capacity for the copperas solution. Third, two settling tanks connected in series, each 7 ft. in diameter and 14 ft. deep. The first of these two was of the Dortmund and the second of the Imhoff type. In these tanks the solids were removed. Fourth, two cinder filters, both 5 ft. square and containing 7 ft. and 5 ft. of cinders respectively. Fifth, a coke filter 2 ft. 9 in. square containing 5 ft. of coke. Sixth, four sand filters, one 5 ft. square containing 5 ft. of sand, one 3 ft. square containing 3½ ft. of sand and two, 1 ft. in diameter, containing 2 ft. of sand.

Lime sludge from the unhairing vats was mixed with the spent tan liquor until it was neutral and the supernatant mixed with the other wastes in the proportions as discharged from the tannery. A solution of copperas (ferrous sulphate) was previously added to the other wastes at the rate of 10 grains per gallon, and the composite passed into settling tanks where it was retained for four hours. Here the solids in suspension were settled out and the supernatant applied to the cinder and coke filters, and the effluents from these were distributed over the sand beds.

The results given in Table I show average analyses of each waste taken separately; of the composite consisting of the different wastes previously treated as already described and mixed in proportion to their respective volumes; and analyses of the settling tank and filter effluents.

The effluent from the coke filter is not included as the results obtained by it were practically the same as those from the cinder filter. There was no additional absorption of color or any other advantage found in the coke to justify the additional cost of the material. The sand filters also gave such similar results in spite of the differences in depth that the one given in the table is thoroughly representative.

TABLE I.—ANALYSES OF THE RAW AND TREATED WASTES AT THE TANNERY OF THE DEFORD LEATHER COMPANY, LURAY, VA.

		Nitrogen as			
Source.	Susp. solids.	Organic and Free am.	Nitrites.	Nitrates.	Oxygen consumed 30'—960 C.
Beam house	850	..	....	....	600
Hair wash	900	..	....	....	200
Spent tan liquor....	1,100	..	....	....	13,000
Composite	1,200	70	....	....	900
Effluent set. tank..	450	55	....	....	530
Effluent cinder filter	160	30	0.29	6.0	205
Effluent sand filter..	30	25	0.17	23.0	55

Under suspended matter it will be observed that the amount in the composite waste is greater than that in any of the individual wastes. This is due to the fact the copperas which was added formed precipitates by its reaction with the various wastes and thus increased the suspended matter. Under the oxygen consumed column it will also be noticed that the analysis of the composite mixture shows a lower result than would be expected considering the ratio in which the different wastes were mixed. This is due to the fact the analysis given for the spent tan liquor in the table was obtained from the average of samples as discharged from the tannery while the spent tan liquor mixed with the other wastes was treated with lime sludge which reduced the concentration from 30 to 50 per cent.

The analysis of the sand filter effluent shows that by the treatment as a whole the suspended matter was reduced from 1,200 in the composite mixture to 30 parts per 1,000,000, the nitrogen from 70 to 25, the oxygen consumed from 900 to 55 and nitrification developed to the extent of 23 parts per 1,000,000. The rates corresponding to the period covered by the table were 250,000 and 200,000 gal. per acre per day for the cinder and sand filters, respectively. No odors developed in the samples; after storage in a warm room for 10 days, there was only a slight color and fish (minnows and sunfish) were able to live in it for more than a month.

The sludge or the solids that accumulated in the settling tank was made up from the suspended matter that came from the tannery through the beam house and hair washing outlets, together with the iron precipitate resulting from the reaction of the copperas added to the various wastes. To this must also be added the sludge resulting from the reaction between the spent tan liquor and the lime sludge. It was black in color, had but little odor, contained some hair, was finely divided and flowed readily through a 4-inch pipe. It dried out to a spadable condition in about 10 days when applied to a depth of 10 inches over a bed of fine cinders 1 foot deep. The amount of dry sludge (100° C.) was 7.3 tons per 1,000,000 gal. of waste or 82 cu. yd. per 1,000,000 gal. with 90 per cent water as drawn from the tanks.

The fertilizing ingredients on a dry basis (100° C.) consisted mainly of the nitrogen, 2 per cent, and lime as calcium oxide, 18 per cent. The other constituents ordinarily found in fertilizer were: Potassium as K_2O, 0.3 per cent; phosphates as P_2O_5, 0.53 per cent. Grease (ether soluble matter) constituted 1.4 per cent. From the figures given above it is obvious that the nitrogen and lime are the only compounds of any particular value as a fertilizer although the entire mixture had a tendency to loosen up heavy soil and form humus and to that extent would be valuable to the soil. Tests carried out using this material on corn planted in clay ground showed decidedly better growth in the fertilized hills and the same was true with oats, wheat and beans, but the test plots were small and located in unfavorable places so that the grain did not mature. The Deford Co. has used the solids from the beam house and hair washing wastes removed by a pond in which these are settled for several years in fertilizing the land on their farm and the results have been very satisfactory as they are now raising better and more grain on their land than is grown on any other land adjoining. The sludge from the settling tank of the testing station was a better fertilizer than that collected in the settling pond as it was well digested, better mixed, and more finely divided.

Testing Station at Haffner Bros.' Tannery, Cincinnati, O.

At the Haffner Bros.' Tannery harness leather is made from cow hides. The process of tanning is similar to the method used at the Deford Co., both companies using the extract from oak bark leached out at the tanneries. At both places a small amount of commercial extract is used but the quantity is small compared to the total amount of tan liquor required. A small amount of bate is used at Haffner Bros. and there are other minor differences in the process of tanning at this tannery not employed at Luray, but the essential features are the same, particularly as they refer to the wastes produced. While the same raw products are used at the two tanneries and the process of manufacturing is practically the same, the impression among tanners is that more water is required in making harness leather and that the tannic acid in the liquors can be used up to a greater extent than is practical in making belting or sole leather. The data obtained on these points, as given later on in this paper would tend to bear out this impression regarding the spent tan liquors, but the other wastes were practically the same at both tanneries.

The purpose of making the study in Cincinnati was to learn whether tanneries in different localities using the same kind of raw material and essentially the same method of manufacture but turning out different kinds of leather, produce wastes of different character, and, if so, what changes in the design of the purification plants would be required. The testing station, therefore, that was designed for this study was a duplicate of the plant operated at Luray, Va., during the latter part of the work when a satisfactory effluent was obtained.

A 5-hp. gas engine direct connected to a 2½-in. centrifugal pump was installed for raising the wastes to the measuring boxes. The spent tan liquor was discharged in the morning before the other wastes began to flow so that a storage tank 14 ft. by 2 ft. by 4 ft. deep for the tan liquors was required. Two settling tanks, each 6 ft. by 12 ft. deep were designed to study different periods of sedimentation and there were four filters, two primary, one of cinders and one of coke, and two sand filters, one to receive the effluent from the coke and the other from the cinders. All of the filters were 5 ft. deep. The cinders and coke were washed to remove the dirt and fine particles and the sand was the ordinary river sand used in the city for concrete work. It was fairly coarse, free of clay or loam and of good hard material.

The spent tan liquor was measured in the tannery while being discharged from the vats and a portion pumped to the storage tank to be discharged into the settling tank with the other wastes in the same proportion the volume of this waste bore to the other wastes. The general wastes were measured every 30 minutes by a weir placed on the main outlet sewer from the tannery.

TABLE II—NUMBER OF GALLONS OF WASTE DISCHARGED PER DAY AND PER HIDE FROM THE DIFFERENT SOURCES AT THE TWO TANNERIES.

Type of waste.	Deford Leather Co, Luray, Va.	Haffner Bros., Cincinnati, Ohio.
	Gallons per day.	
Beam house	65,500	52,700
Hair wash	23,500	Do not wash hair.
Spent tan	14,000	2,800
Total	103,000	55,500
	Gallons per hide.	
Beam house	240	316
Hair wash	85	Do not wash hair
Spent tan	51	17
Total	376	333

In Table II are given the volumes of wastes produced by the various operations in the two tanneries studied, first, on a daily basis and, second, on the basis of the number of hides tanned. At the Deford Co.'s plant where the average number of hides tanned per day was 275 and the hair was washed, the average total flow was 103,000 gal. and the amount per hide was 376 gal. At Haffner Bros. where 167 hides were tanned per day and there were no hair washing wastes except from the dehairing machine the total amount discharged per day was 55,500 gal. and the amount per hide 333 gal. Deducting the hair washing wastes from the Luray totals and those from the dehairing machine, which are included in the beam house wastes, from the Haffner Bros. results, the volume of beam house and spent tan wastes per hide becomes 291 gal. and 289 gal. for the Luray and Cincinnati tanneries, respectively. The amount of tan liquor used per hide at the latter place was only 17 gal., while at Luray it was 51 gal. In a survey made by engineers of the United States Public Health Service it was found that for six large tanneries the total wastes discharged per hide tanned was 270 gal. and the amount of spent tan 20 gal.

In the operation of the test units the spent tar liquor was pumped to the storage tank in the morning at the time when it was discharged from the tannery. From this tank it was added in proper proportion to the beam house waste which was pumped continuously throughout the day to a weir box in which the volume to be treated in the tanks was controlled. The mixed wastes leaving the weir box received the copperas and passed through the two settling tanks, the first of the Dortmund and the second of the Imhoff type. These tanks afforded a computed detention period, based on total displacement of 4 hours to 30 minutes.

From the tanks a portion of the wastes was taken to an orifice box above the filters and the excess wasted. The cinder and coke filters received measured volumes from this orifice box and the effluents from these filters were applied to the two sand filters, each one receiving the entire effluent from one of the primary filters.

The suspended solids do not show the same variation in the composite sample as was pointed out in the discussion of this determination in the results from the Deford Tannery. This was due to the fact that the spent tan liquors were practically neutral when discharged and it was unnecessary to add lime sludge to them and the iron added combined with the small amount of tannic acid, forming iron tannate which was not removed by the method of determining the suspended matter. As the spent tan liquors were not treated before entering the other wastes the oxygen consumed value for the composite sample is the same as that computed from the analysis of the separate wastes.

TABLE III—ANALYSES OF RAW AND TREATED WASTES AT THE HAFFNER BROS. TANNERY, CINCINNATI, O.

Source	Susp. solids.	—Nitrogen as— Organic and free am.	Nitrites.	Nitrates.	Oxygen consumed. 30°—96° C.
Beam house	1,450	100	..	..	800
Spent tan liquor	900	60	..	..	3,900
Composite	1,430	100	..	..	1,000
Effluent set. tank	380	75	..	..	700
Effluent cinder filter	120	30	..	..	300
Effluent sand filter	15	13	0.4	10	85

TABLE IV—VOLUME AND COMPOSITION OF SLUDGE FROM MIXED TANNERY WASTES, AND AN ANALYSIS OF HORSE MANURE.

	Deford Leather Co. Luray, Va.	Haffner Bros. Cin., O.	Horse manure.
Cu. yd. per mil. gal. at 90 per cent. moist	82.0	63.0	...
Tons per mil. gal. dry solids	7.3	5.5	...
Total organic nitrogen per cent	2.1	1.8	0.70
Ether soluble matter (fats)—per cent	1.4	1.0	...
Phosphate as P_2O_5—per cent	0.53	1.0	0.11
Potassium as K_2O—per cent	0.29	0.32	0.63
Calcium as CaO—per cent	18.0	26.0	...

As in the test at Luray, it was found that the cinder and coke filters gave practically identical results, and for this reason the results from only the one set of filters are recorded. Under the circumstances the cinders are the logical filtering media. The effluent from the sand filter was practically free from suspended solids. The nitrogen and oxygen consumed were reduced to 13 and 85 parts per million respectively and nitrification developed to 10 parts per million. During the period covered the rates on both filters were 200,000 gal. per acre per day. No odors developed in samples of the effluent of the sand filter after a 10-day storage at 20° C., the color was reduced to that of weak tea, and fish life was supported for over two months.

The suspended matter removed from the wastes by the settling tanks and referred to in the text and tables as sludge was considerably more at Luray than at Haffner Bros. This was due to the large amount of solids precipitated by the reaction between the spent tan liquor and lime sludge, which has been included in the table. This treament it will be remembered was not used at Haffner Bros. The following table gives the volumes and analyses of the sludge accumulated at the two tanneries and for comparison and analysis of horse manure.

With the exception of the phosphates which was about twice as high at Haffner Bros. as at Luray, the sludges at the two tanneries analyze about the same. The nitrogen and fats are slightly higher at Luray and the calcium higher at Haffner Bros., but the differences are not great. As compared with the horse manure the sludges from both tanneries contain more of each fertilizing ingredient with the exception of the one constituent, potassium.

Disposal of Sludge.

The same method for drying the sludge was adopted at both the testing stations. Shallow filter beds were excavated with the bottom sloping to a central drain and filled with 1 ft. of cinders with a 4-in. layer of sand on the surface. When the sludge was applied in quantities not to exceed 12 in. in depth over the surface the sludge dried to a spadable condition in about 10 days of clear warm weather. During very wet and very cold weather the time required for drying was longer but at the extremes not more than one month was required. There was no offensive odor near the beds and there was no difficulty in removing the sludge with shovels. After accumulating in large piles when removed from the beds the sludge did not become offensive, did not become soaked up with water after heavy rains and there was no reasons why it could not be stored in piles near the filter beds until it would be convenient to haul it away either to be used as a fertilizer or for filling low ground.

No field tests were made to determine the fertilizing qualities of the sludge from the Haffner Bros. Tannery. However, from the analyses and the results obtained by the Deford Co. using the solids from their settling ponds in increasing the fertility of their land, there can be no doubt that this material has considerable fertilizing value, particularly for land deficient in lime. Since it is profitable to ship manure from the cities to the country for fertilizing land, tannery sludge with the lime present and containing twice as much nitrogen as manure ought to be worth at least as much as manure and there ought to be no difficulty in disposing of this sludge for fertilizer.

If it is necessary to dispose of the dried sludge for filling in low ground it will probably be advisable to mix the cinders from the boilers with the sludge to facilitate further drying. Underdrainage should also be provided to prevent the storage of rain water in the sludge.

Conclusions.

As a result of the tests at Luray three tanneries in Virginia, the Deford Co. of Luray, the Lease & McVitty Co. of Salem, and Cover & Sons of Elkton, were sufficiently interested in the purification of their wastes to contribute enough money to build a plant to test out on a large scale the results obtained in the smaller units. Plans were prepared for this plant, and construction was started March 5th.

This plant will treat 10,000 gal. per day and in its design advantage was taken not only of the information gathered at the testing station operated at Luray, but also the further experience gained from the tests conducted at Cincinnati.

The conclusions reached in these tests and their practical adaptation in this larger unit may be briefly summarized as follows: First, a storage tank for spent tan liquor to be used, also for treatment of this liquor with lime sludge if it is strongly acid. As it is customary to discharge tan liquor intermittently or but once a day, this tank is required to distribute the flow throughout the day. For the 10,000 gal. plant at Luray duplicate tanks each 10 ft. by 6 ft. in plan and 3½ ft. deep with dosing appliances are provided. Second, solution tank for the ferrous sulphate (copperas) solution. These tanks are in duplicate, each 1½ ft. by 2½ ft. in plan and 2 ft. deep and have the necessary regulating devices. Third, a settling tank of sufficient capacity to allow a minimum detention period of 2 hours computed on the displacement basis. The tank for this purpose at Luray is 20 ft. long by 8 ft. wide by 11 ft. deep and contains baffles and scum boards for holding back the scum. Fourth, cinder filters having a total depth of 5 ft. of cinders or 4 ft. exclusive of the underdrains. At Luray this is 42 ft. by 30 ft. Fifth, sand filters. As good results were obtained with a depth of sand of 2 ft. as of 5, the sand filter at Luray 42 by 30 ft. is divided into three sections having 2, 3 and 4 ft. of sand laid over underdrains which occupy a maximum of 1 ft. sloping to zero at the sides. Separate outlets are provided for each section for taking samples and provisions were made to increase the depth of the shallow sections if it becomes necessary. These filters as well as the cinder filters will operate at a rate of 200,000 gal. per acre per day. Sixth, sludge beds with sloping bottoms containing 1 ft. of cinders overlaid with 4 in. of sand. For a 10,000 gal. unit treating the type of wastes produced at Luray an area of about 600 sq. ft. is required.

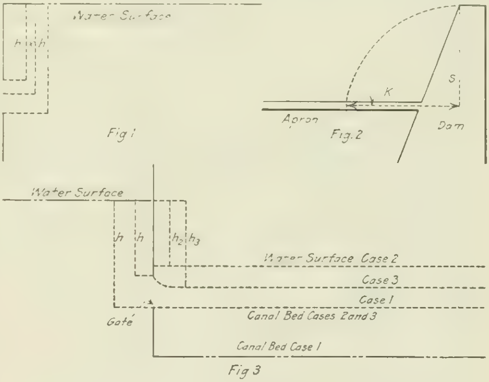
In the operation of the testing units it was found that better results were obtained by operating the filters at low rates throughout the 24 hours, rather than applying the entire dose for a given rate during the working day. In the permanent unit the settling tank is designed to store enough wastes during the day to operate the filters during the 14 hours the tannery is not in operation. During the latter part of the tests sand filters 2 ft. deep gave as satisfactory results as the deeper filters, but these filters were only 1 ft. in diameter and the results were not directly comparable. It seemed advisable, however, to construct the larger filter in the permanent unit of three different depths to definitely decide this point.

Calculations for Design of Irrigation Structures

Formulas of flow for use in calculating discharge through highgates of irrigation canals are given by Mr. Charles W. Helmick, Helena, Mont., in the June Transit, a publication of the College of Applied Science of the University of Iowa. Extracts from the article follow:

In designing headworks for irrigating canals it is frequently necessary to construct a low diversion dam across the channel of the river furnishing the water supply, not for the purpose of an impounding reservoir, but merely to divert the water to the intake canal.

If the dam be a low one, raising the water but a few feet above the general river bed, and the waste weir extend over the greater part of the channel, the drop from the crest of the weir to an apron below may be made in one step so as to break the fall, or the drop may be into a water cushion, which is preferable when such can be economically constructed.



Figs. 1-3.—Diagrams for Flow Calculations.

The crest of the weir should be at the height that the water should stand above the gates of the intake canal to provide the maximum volume that the intake canal is to carry to the impounding reservoir or to the lands to be irrigated, for in many cases the low water flow will be found to have been acquired by prior appropriators, and only the flood waters, supplemented by what water can be obtained from the river when its water is not otherwise being used, will be found to be available for the new project.

The prior rights will therefore necessarily have to be first provided for, and gates of ample capacity leading downstream must be provided for all such whose diversion lie below the diversion weir, and as it will generally be found to be more economical to construct the headworks to the intake canal and the gates for prior appropriations in one structure, and in the location of the canal, this idea should be given due consideration.

The quantity of water required for the prior rights taken below the diversion, together with the maximum as wanted through the intake canal, will determine both the number and dimensions of the gates when the head upon the same shall have been determined. Flashboards may, however, be used to increase this head, but they are difficult to operate, and the preferable plan will be found to be to increase the number of gates rather than to be troubled with their continued operation.

Calculations.

Large orifice in a thin plate and its adaption to a weir (Fig. 1):

Let the notation be as shown in Fig. 1, breadth being unity.

$dQ = (2g)^{\frac{1}{2}}\, x^{\frac{1}{2}}\, dx.$; integrating, $Q = 2\text{-}3\, (2g)^{\frac{1}{2}}\, (h^{\frac{3}{2}} - h_1^{\frac{3}{2}})$ Eq. (1)

If $h_1 = 0$, then $Q = 2\text{-}3\, (2g)^{\frac{1}{2}}\, h.\, h^{\frac{1}{2}}$ Eq. (2)

Divide by h, we have $v = 2\text{-}3\, (2g)^{\frac{1}{2}}\, h^{\frac{1}{2}}$. Eq. (3)

which is the maximum mean velocity of the water over the weir. Taking the coefficient of 0.62, this will give practically the well-known weir formula.

To find where jet will strike the apron with velocity from Equation 3 (Fig. 2):

Time of falling through (s), $t = \dfrac{(2s)^{\frac{1}{2}}}{(g)^{\frac{1}{2}}}$

$k = v.\, t. = 2\text{-}3.\, (2g)^{\frac{1}{2}}\, .\, (h)^{\frac{1}{2}}\, .\, \dfrac{(2s)^{\frac{1}{2}}}{(g)^{\frac{1}{2}}} = 4\text{-}3.\, (s)^{\frac{1}{2}}\, .\, (h)^{\frac{1}{2}}$

Eq. 4.

As no coefficient for velocity was used, these results are but approximate, but they are probably sufficiently accurate for general work.

The apron must be made wide enough to fully break the jet and, in practice, a wave will form at the apron which will form a water cushion but which will also tend to increase the scour below.

Flow through gates.

Case I.

Free flow from gate with no back water.

$Q = 2\text{-}3\, (2g)^{\frac{1}{2}}\, .\, (h^{\frac{3}{2}} - h_1^{\frac{3}{2}})$. Eq. 5, same as Eq. 1.

Case II.

Surface of water in canal, above top, or at top of gate.

Evidently, the only head producing flow is (h_2).

$Q\ \frac{1}{2}\, (2g\, h_2)^{\frac{1}{2}}\, .\, (h-h_1)$ Eq. 6.

Case III.

Water surface of canal higher than bottom of gate.

This is evidently a combination of Cases II and I, the flow through the portion of the gate between floor and water surface corresponding to Case II.

$Q = (2g)^{\frac{1}{2}}\, .\, (h-h_3).\, h_3^{\frac{1}{2}} + 2\text{-}3\, (2g)^{\frac{1}{2}}\, .\, (h_3^{\frac{3}{2}} - h_1^{\frac{3}{2}})$

$= (2g)^{\frac{1}{2}}\, [2\text{-}3\, (h_3^{\frac{3}{2}} - h_1^{\frac{3}{2}}) + (h-h_3)\, h_3^{\frac{1}{2}}\,]$ Eq. 7

In the above no account is taken of the velocity of approach in the river channel, and this may generally be neglected unless it exceeds 2 ft. per second, as owing to wave action the errors in measuring the water surface in the canal are necessarily large. No coefficient of contraction is given.

If there be but one opening to the intake canal or river, and this through a broad face, it will very likely range about 0.62 to 0.64, inasmuch as there will be contraction on but three sides.

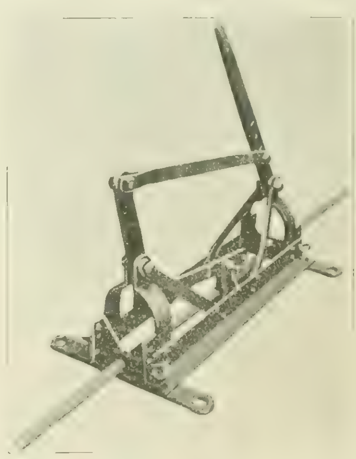
If there are two or more openings which are wide compared with distances between them, it will range much higher, possibly 0.65 to 0.75, depending on conditions of flow in the canal. Case III will be found to be the one under which measurements will generally be made, but the great difficulty will be in measuring the distance h_3, even approximately, as the velocity of the water through the gate with $h_2 = 2$ to 2.5 ft. will approximate 10 ft. per second, which causes violent wave action and a piling up of the water below the gate until the normal velocity in the canal is approached.

Case I will rarely be used in a main canal, but it may come into use in turnouts to laterals.

Case II will be found useful when there is an abundance of water to fill the canal to its maximum capacity, and if a reasonably close measurement of h_2 can be obtained the velocity of approach in the river channel when it is 2 ft. per second or greater should be considered.

Pipe Pusher

A machine that is claimed to make a labor saving of 60 per cent to 90 per cent in the installation of water and gas services is illustrated. This pipe pusher is equipped with a variable leverage making it possible to adjust the speed of the push to the hardness of the ground. It also can be employed to pull out the pipe without changing the whole machine from end to end. In operation the pusher is fastened to the bottom of the ditch or cellar, with ⅜ in. stakes driven through the holes in the bed plate of the machine. The pipe is then placed in the guides and the gripping device adjusted. The operating lever is worked by one man. It is stated that from 150 ft. to 200 ft. of pipe can be coupled together and pushed to place per hour, working in reasonably hard ground. The machine is built of forged steel. It is 30 in. long, 18 in. wide and weighs 70 lb. It is manufactured and sold by Horace A. Brown, Ottumwa, Ia.



The Giant Pipe Pusher.

Personals

O. Laurgaard has been appointed City Engineer of Portland, Ore., succeeding Philip H. Dater, resigned.

Andrew T. Hansen, Chief Deputy City Engineer, has been appointed City Engineer of Los Angeles, Cal., succeeding Homer Hamlin.

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The Overbreakage in the Catskill Aqueduct Tunnels

In tunnel work through rock there is usually some "overbreakage" beyond the "payment line," that is, the line within which the quantity of excavation is paid for, and outside of which all excavation is done at the contractor's expense. It is therefore important both to tunnel engineers and to contractors not only that specifications be fairly drawn, but that the probable amount of "overbreakage" be approximately known in advance.

In building the Catskill aqueduct to New York City careful records were kept of the amount of overbreakage in the different sections of the 49 miles of tunnel, and the specifications were so drawn as to encourage the contractors to reduce the overbreakage to a minimum. Before summarizing the data as to overbreakage we shall give a brief outline of the specified method of determining the pay yardage both of excavation and of concrete lining.

Where the tunnel dipped below the hydraulic grade line and there would consequently be an internal pressure of water on its walls, it was 14 ft. in diameter inside the concrete lining. Let us call this inside concrete line (a circle 14 ft. diam.) "the inside line." Parallel to this line and 10 ins. outside of it is another line within which no rock must project, and this may be called "the clearance line." Parallel thereto and 23 ins. outside of "the inside line" is the "payment line," beyond which neither excavation nor concrete is paid for at the regular contract price. Excavation beyond this "payment line" may be called "overbreakage."

In the Catskill aqueduct specifications it was provided that the contractor should be paid $2.50 or $3 per cu. yd. of overbreakage as compensation for both this extra excavation and the extra concrete lining necessitated by the overbreakage. Since the contractor did not furnish the cement, it was believed by the engineers that this payment for overbreakage would be a fair compensation for any unavoidable overbreakage, but not so large a compensation as to make it profitable to the contractor. Between "the payment line" and "the clearance line" there was another line that may be called "the average line," which was 15 in. outside "the inside line"; and it was specified that the concrete in any cross-section must average 15 in. thick.

The above dimensions relate to the "pressure tunnel" sections, aggregating 35 miles in length. There were 14 miles of "grade tunnels" of horseshoe section that did not dip below the hydraulic grade line, and the inside maximum dimensions of a "grade tunnel" were 13 ft. 4 in. across by 17 ft. high. The "clearance line" of a "grade tunnel" was 5 to 7 in. outside "the inside line"; and the "payment line" was 13 in. outside the "clearance line." These lines relate only to the side walls and roof.

There was considerable variation as to overbreakage, not only because of difference in the kind of rock (which ranged from soft shale to tough granite), but because of the position of the tunnel with respect to the dip of the rock strata, also because of the variation in the managerial skill of the different contractors. In nearly 12 miles of tunnels through shale and slate, there was no overbreakage at all, as the average of 8 contracts; but in fact the average excavation fell half an inch inside of "the payment line." One contractor managed to average a full inch inside "the payment line," but another contractor averaged an overbreakage 2¼ in. outside "the payment line."

In four tunnels through limestone, totaling about 1¼ miles, the overbreakage averaged 1¾ in. outside the payment line.

In 19 tunnels through granite and gneiss, totaling about 8 miles, the overbreakage averaged 3¾ in. outside the "payment line"; but in one 900 ft. tunnel there was an average underbreakage of ¾ in., while another tunnel (7,330 ft.) the overbreakage averaged 5¾ in. In this last named tunnel the contractor purposely excavated well beyond "the payment line" in order to avoid the expense of trimming projecting rock. Moreover this gneiss was blocky and joints were numerous.

In 10 tunnels through Manhattan schist, totaling about 8½ miles, the average overbreakage was 2½ in., but in one tunnel the overbreakage averaged only ¾ in., whereas in another it averaged 8 in. because the schist was much disintegrated.

Those experienced in tunnel work will see that the overbreakage would have been somewhat less had it not been for the specifying of an average thickness of concrete (see "the average line" above defined). Ordinarily only a "clearance line" (or neat line) and a "payment line" are specified.

In the softer rocks, like shales and limestones, where air-hammer drills can be effectively used in trimming the sides, the overbreakage averages considerably less than in the tough rocks, like granite, gneiss and schist. In tough rocks the contractor drills his blast holes deep enough to insure breakage beyond the "payment line," so as to reduce the trimming. One of the contractors used a large number of horizontal rim holes in excavating the lower half a pressure tunnel through gneiss, and thus secured an underbreakage of ½ in. inside the "payment line."

The Economic Inequity of "Full Crew Laws"

In another column we have commented on the partisanship of "Leslie's Weekly," a partisanship that occasionally leads to injudicious statements. An intelligent partisan, however, makes judicious comments with at least as great frequency as those that are injudicious. So when "Leslie's Weekly" attacks the economic folly of the "full crew laws" that are enforced in twenty states we find ourselves in complete sympathy with the indignation over the fact that 20,000 trainmen are uselessly employed because labor unions have been politically powerful enough to secure pernicious class legislation.

New Jersey has repealed its "full crew law," but the governor of Pennsylvania has just vetoed a similar repeal, and in doing so has written the longest veto statement in his history. The very length of his explanation of the veto is symptomatic of a troubled conscience. He quotes President Wilson's desire that, at least during the war, all strife between capital and labor be suppressed. But was it not less than a year ago that President Wilson himself settled a controversy by giving railway trainmen an increase of 25 per cent in wages? Curious indeed is the logic by which the war is made an excuse for raising the wages of trainmen, and the same war is used as an excuse for holding trainmen in useless jobs; and at the very time that farms and factories are in desperate need of more men!

The cowardly politics that infests both congressional and state legislatures is fast becoming unendurable to fair-minded men. We have usually looked to our state governors for a little more courage and fairness than our state legislatures exhibit, but Governor Brumbaugh of Pennsylvania has proved to be as much of a peanut politician as the most partisan of the legislative "representatives" that represent special or class interests.

Why High Priced Labor Makes Use of Machines More Profitable

In China where laborers receive only 15 ct. a day, there is often no marked saving effected by the use of steam shovels or concrete mixers in place of hand work. In America, where common laborers are now receiving as high as $3 a day, there is strong reason for the use of labor-saving devices. Even when wages were half what they are today, and when machines were less efficient than they now are, it was usually profitable to supplant men with machinery unless the job was a very small one. We wonder whether all superintendents and managers realize that now that wages are higher, it usually pays to use machinery even on relatively, small jobs.

Those of us who have managed work on the Pacific Coast, where common labor has always been scarce and high, have long ago learned how to do most kinds of work at unit costs as low as that of similar work in eastern states where labor was relatively cheap. Necessity drove us far-westerners to exercise our wits, and thus led not only to the greater use of existing labor-saving machinery, but to the invention of new devices and methods. One Californian, for example, remodeled the old style drag or slip scraper, and made the now well-known "Fresno scraper," which is usually hauled by four mules hitched abreast. Another Californian devised the hydraulic giant or monitor for digging and moving gravel, sand, etc. It was a far-westerner—no one knows who—that devised the jerk-line method of driving teams of 6 to 20 head of mules or horses. The "trap" for use in loading wagons by "fresnos" or other scrapers was also a western device. And so we might go on enumerating the things that were invented to enable one man to do the work that previously had required two or more.

"Necessity is the mother of invention," and, perhaps, if the truth be told, laziness is the grandmother; for to escape the swelter of hard work as well as to make shirkers more willing to work, the wit of man has ever been on the alert to substitute horse flesh for man flesh and steam or gasoline for both.

In another editorial we give some valuable facts about the use of roller bearings instead of plain bearings on small dump cars. Take that idea alone and see how you may be able to apply it to your own problems. Are you using wheelbarrows or push carts or buggies? Why not have roller bearings for them? If it pays to use roller bearings on a motor truck, it will pay even more to use such bearings on a wheeled vehicle operated by man power.

Study always the possible adaptation of devices to your own special work. Read to get ideas, not only those that you can apply directly, but those that you may possibly modify for your purpose. The reading pages and the advertising pages of a practical periodical are designed to stimulate men's wits, not merely to furnish them with a complete solution of every economic problem. Read, think, adapt—let this be the practical man's motto.

Must We not Eventually Operate Motor Trucks With Coal Gas?

Some Englishman with his wits about him thought of a way of overcoming the H. C. G.—high cost of gasoline. He was operating a line of motor buses in London and it took a gallon of gasoline to move a bus four miles, at a cost of 5 ct. a mile for the gasoline. Knowing that coal gas could be used to drive the motors, he conceived the the idea of filling a large canvas bag with gas and carrying this gas holder on top of the bus. It was soon demonstrated that a bag of gas, holding 450 cu. ft., was sufficient to propel the bus almost 17 miles at a cost of only 2 ct. a mile, gas being purchased at 78 ct. per 1,000 cu. ft.

There is food for thought in this achievement. If 1,000 cu. ft. of coal gas costing 80 ct. will drive a motor bus nearly 40 miles, and do the work of 10 gal. of gasoline costing $2, why will it not be profitable to use coal gas for motor truck haulage wherever coal gas is available? The price charged for coal gas in most American cities is approximately $1 per 1,000 cu. ft., but this includes the interest and depreciation on an expensive system of mains that deliver the gas to the individual consumers. Coal gas is manufactured at a cost of less than 40 ct. per 1,000 cu. ft. in the gas holders, in most cities. If, then, motor truck owners were to purchase their gas at or near the gas holders, it would seem that it could be profitably sold by them for about 60 ct. per 1,000 cu. ft. At any rate the price should never exceed 80 ct. per 1,000 cu. ft. At the rate of 80 ct. for gas, gasoline would have to be sold at 8 ct. a gallon to compete with coal gas for driving motor trucks.

It is evident of course that the large size of the gas bag and the necessity of frequent replenishing of the gas supply are objections to the use of coal gas for motor truck purposes. While it would be feasible to pull a very light trailer carrying a bag filled with 1,000 cu. ft. of gas, it would seem more practicable to compress the gas and carry it in steel tanks. In this way it would be possible for a motor truck to carry sufficient coal gas, in relatively small space, to supply the motors for an entire day's run.

The supply of petroleum, great though it is, is small indeed compared with the supply of coal. Coal can be converted into gas, which is susceptible of being compressed even to a liquid, but this extreme compression is of course not necessary. Compressed coal gas seems to offer the most practicable solution of the problem of economically supplying power for our rapidly growing number of motor vehicles. Powdered coal will doubtless come into general use wherever steam is used as the primary power, as in factories and locomotives.

During the last 12 months one automobile factory alone turned out nearly three-quarters of a million cars, or one-fifth as many motor cars as there were in America a year ago. That same factory will produce fully a million cars during the next year, according to present plans and prospects.

A small pleasure car consumes fully 30 gal. of gasoline annually, on the average. A large motor truck consumes half this amount in a single day! Consider, then, what we shall face when motor truck building begins to assume proportions comparable to pleasure car production. Does it not inevitably spell the necessity of using coal gas instead of gasoline for motor truck operation?

How to Reduce the Tractive Resistance of Dump Cars by Means of Roller Bearings

Many mistakes have been made by civil engineers in calculating the tractive resistance of small dump cars on construction work. Knowing that the resistance of large freight cars on a well ballasted level track may be lower than 6 lb. per ton of 2,000 lb., it has frequently been assumed that small cars on a light track would offer a resistance not greater than 10 lb. per ton, whereas the actual resistance is usually 30 to 40 lb. per ton.

In a paper to be read at the October meeting of the American Institute of Mining Engineers, Mr. P. B. Liebermann, Chief Engineer of the Hyatt Roller Bearing Co., gives the results of some tractive tests on small cars which will open the eyes of many of our readers. The tests show that at a speed of 6 miles an hour loaded mine cars of 2 to 4-ton capacity offer a resistance of about 29 lb. per short ton when ordinary bearings are used, and 12 lb. per ton when Hyatt flexible roller bearings are used. The wheels of the car were 16 in. diameter and the track was 30 in. gage.

Mr. Liebermann gives the following formulas for calculating the tractive resistance, based on tests ranging between 1 and 12 miles an hour speed.

$R = 26 + 0.45\ S$
$r = 9 + 0.45\ S$
R = train resistance of loaded plain-bearing cars on level track, in pounds per short ton.
r = ditto for flexible roller-bearing cars.
S = speed in miles per hour.

At speeds above 12 miles an hour the air resistance becomes noteworthy, for this varies as S^2, but at speeds of less than 12 miles an hour this factor is negligble.

These formulas relate to clean tracks, but tracks covered with coal dust were found to increase the train resistance 30 per cent for either type of bearing. Tests made with empty cars showed that the train resistance per ton is about 40 per cent higher for plain-bearing cars and about 15 per cent higher for roller-bearing cars than would be obtained from the above formulas for loaded cars. Of course the resistance of gravity is 20 lb. per ton for each 1 per cent of grade.

Mr. Liebermann estimates that it costs about $20 to equip a 3-ton car with roller bearings, but that this increased investment may frequently be offset by the reduced investment in locomotive and rails. He shows that in a typical coal mine whose output is 1,000 tons of coal per day, an annual saving of $2,000 a year in operating expenses may be effected by the use of roller bearings on 164 mine cars; and that a 3-ton locomotive will haul a train of 42 roller-bearing cars carrying 126 tons, as compared with an 8-ton locomotive hauling the same size train of plain-bearing cars. Moreover, 20-lb. rails would suffice for the 3-ton locomotive as against 30-lb. rails for the 8-ton locomotive. In this example he assumes that the grades are so adjusted in favor of the loaded cars that the tractive resistance for the loaded trip will be the same as for the return empty trip.

Although Mr. Liebermann's tests and calculations relate to mine car haulage they are applicable to any haulage involving the use of small cars on light rails, such as moving earth on railway construction or in hauling gravel from the pits to the crushing and screening plant. Dirt movers and pit owners, therefore, will do well to consider the marked saving that may be effected by placing roller bearings on their cars.

Scientific Management Applied to Hens

"Whenever I eat an egg," said a food conservationist, "I think of the chicken that the egg might have become, and whenever I eat a chicken I am worried over the eggs it might have laid." But would it not be a wiser waste of worry to think of the 200 eggs that the average hen annually falls below those laid by the most scientific hen?

Agricultural papers have been extolling the productiveness of "Queen Mary," if we remember her highness' name aright, a hen that last year went 283 times to the nest without scoring a single goose egg. Think of it—283 eggs a year from one hen when the average laid by 360,000,000 hens in America is only 83 eggs!

Naturally such a contrast makes one's thoughts turn toward the cause of it. Investigation discloses the reason, or rather reasons, for the fundamental cause is scientific management—not management on the hen's part, for even the regal record-breaker, "Queen Mary," is said to have only the brains of an average, homespun hen. It seems that the process of producing a 283-egg hen is essentially the same as the process of increasing the output of an automobile factory without increasing the number of employes, namely, by giving long and careful thought to every factor that affects production.

A hen eats a certain weight of food daily, and that food contains a certain number of heat units, or calories, capable of doing a limited amount of work. If the hen lives in a cold coop, a large number of the heat-units absorbed as food are required to maintain her bodily temperature at 98 degrees. Ergo, a correspondingly small number of heat-units are available for conversion into eggs. From which it follows that the coop must be warmed by fuel in cold weather if the eggs are to be numerous.

Hens, like humans, have temperament, some being placid, others excitable, but none capable of enduring annoyance without loss of efficiency. So the scientific manager of a hennery objects even to the entrance of a single stranger into the egg factory. It ruffles the spirits as well as the feathers of his workers. As for dogs or cats—they are absolutely taboo.

Life must not be one endless panorama of quietude and monotony for the successful hen, however, so the corn is partly covered with loose earth and chaff, necessitating vigorous scratching to uncover it. This "back to nature movement" pleases the hens and they respond with more eggs.

There are many other "nifty stunts" that shrewd students of henology have devised, but we must stop after indicating one more. Long before Darwin wrote his "Origin of Species," it had been discovered that, by selecting and breeding animals, almost any quality could be made more pronounced. Indeed, Darwin's great conception of evolution through "natural selection"—as he called it in distinction from man's "artificial selection"—came to him as a result of his thinking about man's selection of animals for breeding. But Darwin's evolutionary hypothesis served in turn to stimulate attempts to improve domestic animals by more careful selection for breeding purposes. Finally—within very recent years—along came the scientific manager, the man who counts and measures and thinks; and he devised a "trap nest" that catches any hen that enters it to lay an egg. Presto! The egg output of every hen in the yard is thus made known, for she can not leave the nest until released by a man who records her number and credits her either with a goose egg or a hen egg. Forthwith it becomes evident that many hens are drones, slackers—what you will for a name for an individual that eats more dollars than he produces. On the other hand, it is disclosed that a few hens are abnormally fine layers, and to these is thenceforth assigned the duty and the honor of reproducing their kind.

Even the seemingly prosaic occupation of managing a hen ranch has thus come to be both interesting and scientific. Indeed, what managerial job is there in this world that does not take on dignity when brains and science enter into it?

A Million Pound Blast in France

A few weeks ago a million pounds of high explosives were set off by the English under the German trenches on the Messines Ridge in France. The explosion was heard in London, 130 miles away. This is the largest blast ever fired. If each pound of explosive moved only one ton of earth and rock, 1,000,000 tons were hurled into the air.

About 200 miners are said to have driven a tunnel, or rather a drift, 1¼ miles long in 6 months. In 19 chambers located in cross drifts, the explosives were placed, 25 tons to the chamber. These were detonated simultaneously with an effect that was described as appalling.

The speed of driving the drift appears to have been 36 ft. a day. There is nothing remarkable in this performance if the ground was not bad and if it was possible to use explosives liberally. It is not unlikely, however, that explosives were used in small charges so as not to disclose the location of the sapping work to the enemy.

Partisanship of "Leslies' Weekly" in the Railway Controversy

"Let the war abolish fads," says Leslie's Weekly. Among "fads" it classes the valuation of the railways, and speaks of the thousands of civil engineers who are now wasting their time trying to ascertain nobody knows exactly what nor why. Speaking of the Congressional act under which the valuation is being made, Leslie's Weekly says:

> No one seems to know just what the act means or calls for or what advantage it will be to the country.

For several years Leslie's has championed corporation rights and has done a good work in making the public see that the corporations are not only economic institutions of immense social value, but that they have been unjustly made the targets for political abuse. But any one who becomes a continuous champion or advocate of one side of a conflict is in grave danger of losing his sense of justice, although it was a sense of justice that originally prompted his action. We fear that Leslie's Weekly is slipping into the class of the I. W. W. soap-box orator who can see nothing but evil in those who disagree with him.

For a generation the Interstate Commerce Commission had been asking for an inventory and appraisal of the physical property of all the railways, when at last Congress passed a bill that provides for such an inventory and appraisal. It is true that the bill provides that other data also be secured, and it is true that there is a question whether the I. C. C. must fix a definite "rate-making value" for each railway. This element of ambiguity in the bill may be regrettable, but certainly no one but a violent partisan would use such language about it as that above quoted from Leslie's Weekly.

It is our opinion that in spite of the ambiguity of the act, the I. C. C. will eventually decide to establish a definite rate-making value for each railway, for that is the obvious purpose of the bill. Only a cowardly commission could refuse to shoulder the full responsibility of making such a decision, even if every State Railway Commission in America were to demand that the Interstate Commerce Commission leave the "rate-making value" undecided.

As we stated a few weeks ago, the railway companies have thus far made little progress in securing adequate rates because they have not presented satisfactory appraisals of their properties. They have attempted to belittle the usefulness of such appraisals and have ridiculed the judgment of anyone who believed in the desirability of an appraisal. What would be thought of a merchant who refused to inventory his stock, yet claimed that his profits on his investment in that stock were abnormally low? Would it not be suspected that he was insincere?

If the railway appraisal now in progress serves no other purpose than to establish definitely the cost of reproducing the railways, it will be worth many fold the cost of making it, for it will remove the cancer of suspicion about railway values and enable the public thenceforth to realize the vast worth of railway property and relatively small profit earned upon its real value.

The Necessity for Increasing the Attendance at Technical Schools

To the Editor: There is an imminent matter of vital importance to the American nation concerning which very little, if anything, has been said in the newspapers—hence the presentation of this letter, and with it an urgent request for its publication in your columns and, subsequently, for a wide circulation through copying by the public press of the entire country.

I refer to the depletion of the classes in technical schools, first, by wide-spread volunteering for the army and navy, and, second, by conscription. This subject received much attention at the Washington meeting, on the 6th and 7th inst., of the Society for the Promotion of Engineering Education, an organization of 25 years' standing and composed of most of the leading American instructors in all lines of applied science, and also a few prominent practicing engineers. The meeting was addressed by such distinguished men as the Secretary of War, the Chief of Engineers of the U. S. Army, and the Director of the Bureau of Standards. The five sessions held by the society on those two days were devoted almost exclusively to questions of public welfare, principally connected with the war, its subsequent conditions, and its anticipated problems.

As I attended all of the sessions from start to finish and took the deepest interest in the entire proceedings, I feel justified in making the following statements, and in claiming that they express the opinions of the most profound thinkers of America:

1. The larger part of the civilized world will have to be reconstructed after the war, not excluding our own great railroad system, which undoubtedly will have deteriorated on account of over-use and lack of adequate up-keep.

2. Such reconstruction is almost exclusively the work of engineers.

3. The European technical men have been killed off by thousands during the past three years; and their slaughter will not cease until the war ends. Moreover, it is more than probable that many American engineers who serve in Europe will never return to our shores, and that a large number of those who do come back will be more or less incapacitated from active professional work.

4. The technical schools of all the other warring countries than ours have practically been out of commission for three years, thus cutting down there, almost to zero, the supply of new men for the engineering profession.

5. The call to arms in this country by both volunteering and conscription it is feared will soon have reduced to about one-half the attendance at the technical schools of the United States, while instead of being halved it ought properly to be doubled.

6. In spite of the present paralyzation of many lines of engineering work, due to the cessation of large constructions and to the absolute lack of capital for important new projects of a peaceful character, the demand for young graduates of technical schools by the manufacturers of war supplies is so great that there is already a marked dearth of such assistance, which dearth will be more and more accentuated as the war progresses, and as the call for ships, guns, ammunition, aeroplanes, automobiles, and other war paraphernalia increases.

7. Until the United States entered the war, it was almost certain that most of the reconstruction work of the world would be done by American engineers, and in any case they are sure to get a fair share of it; but it seems a shame that this country should miss such a golden opportunity as that which lies before it for securing the lion's share.

8. The capacity of the old, experienced, and well-established American engineers for doing work is practically unlimited, provided that there be no shortage of young, properly-educated assistants; because most technical men of mature years have developed highly the faculty of management. On that account the average total annual amount of work engineered by such men in this country could readily be increased five fold, or, possibly even ten fold, without causing undue overstress either physical or mental; and, consequently, the great mass of the work of world-reconstruction could emanate from the United States and be handled abroad by American engineers.

9. It is beyond question that, for the next 10 years or more, engineering is everywhere going to be the most lucrative of all the professions.

From these nine premises what is the important deduction to be drawn?

Evidently it is that, by some means or other, we must manage not only to prevent any falling off in the attendance at our technical schools both during and directly after the war, but also greatly to increase it.

And how can this be done?

The answer to this question is not difficult. It is as follows:

1. By urging more young men to go to college, and by persuading their parents that it is their duty to send the boys there for the ultimate good of both themselves and the country.

2. By inducing all sub-freshmen who have shown any special aptitude for mathematics, mechanics, or chemistry, to take the technical courses.

3. By discouraging the enlistment into the army and navy of all students in technical institutions, but, on the contrary, by encouraging them to remain and graduate, if possible. Of course, those who are drafted will have to serve; for it would, manifestly, be unfair to the rest of the youths of the country to excuse a man from going to the front simply because he is a technical student. Such drafted students, however, should generally be sent to the engineer corps, because their services in that branch of the army would probably be more effective than in any other, and because the training they would receive therein would be likely to serve them in good stead in after years when practicing in the engineering profession.

4. By granting Government aid to those youths of evident special ability in technical lines who are unable to raise the money necessary for a course of instruction.

If these four steps be taken, the unique opportunity referred to will not be lost; and this country will then become the leader of the world in activity, effectiveness, and wealth.

Let me, therefore, most earnestly implore all youths who are ready for college this fall, and who are not in any way unfitted for technical careers, to take up some branch of engineering or technology; and let me entreat the parents or guardians of such youths to exert their influence so as to induce the boys to choose that line of study for their life work. Remember: it is not only for the good of the country that I make this appeal, but also for the ultimate benefit of the young men themselves!

Some reader of this communication may remark that such an appeal would possess more force if it were to come from a national engineering society than when emanating from an individual engineer. Very true! But until quite lately there has been no engineering society which draws it membership from all lines of technical activity; and the one which is now being formed, viz., the American Academy of Engineers, has not yet received from Congress the national charter for which it has applied. Were that association today fully organized and duly recognized by the Government, it assuredly would make such an appeal as this; and, in my opinion, that appeal would immediately be responded to by the nation, for the American people certainly are sensible enough to heed seriously any words of warning coming from a select body of the most practical men in the land.

It is true that such an appeal might readily be made by the old and well-established Society for the Promotion of Engineering Education; but, if so, it would generally fall upon deaf ears, because it would immediately be remarked that the professors were simply trying to recruit their classes and were "rooting" for their schools. On that account, at the meeting of the society I refrained from offering a motion to the effect that it officially make this appeal, which I then had in mind. However, the society is going to do what it can to help the profession by publishing and circulating widely the speeches of Secretary Baker, Brigadier General Black, and Dr. Stratton hereinbefore referred to. These addresses will corroborate what I have said in this letter; and I trust that they and my earnest entreaty combined will result in augmenting materially next September the attendance at the technical schools of the United States.

J. A. L. Waddell,
Consulting Engineer.
Kansas City, Mo.

Power of Public Service Commissions

To the Editor: My attention has been called to your criticism in your July 18 issue of my statement that "these commissions all have repressive but not regulatory powers."

The Century Dictionary defines "repress"—"to press back or down effectually." This power the commissions have. They can suspend a rate and, as a matter of fact, their almost invariable practice is to suspend a rate when it is filed. They can reduce a rate and have reduced many rates, and one unfortunate feature is that by the time all other rates affected are adjusted the loss in revenue is about four times the loss involved in the original reduction.

The Century Dictionary defines "regulate"—"to put or keep in good order, as to regulate the disordered state of a nation or its finances." These powers the commissions do not have. They cannot order a rate advanced nor have they powers to put or keep in good order the affairs of the companies over which they have jurisdiction.

Times without number, through all history, human ingenuity has made efforts to devise a method of creating governing bodies with authority but relieved of responsibility. Always the effort has failed. Thirty years' experience with commissions indicates the failure of this effort. If this method of governing is to be maintained, they must be made truly regulatory.

L. F. Loree, President,
Delaware & Hudson R. R.
New York.

Ditching Marsh Land With Dynamite

In ditching marsh land covered with a mat of dead grass and peat from 4 in. to 1 ft. thick, the best results with dynamite were obtained by first cutting the surface of the peat at the center and sides of the proposed ditch. At first, states Mr. F. M. White in Vertical Farming Magazine, trials were made by placing dynamite about every 3 ft. apart in what was to be the center line of the ditch. It was expected that the top layer of peaty soil would be broken and torn off, leaving a good, clean ditch. The first trial showed clearly that this was not a feasible method of ditching with dynamite. A large part of the debris fell back in the ditch, particularly the top layer of matted grass and peat, so that the ditch was not at all satisfactory.

In order, if possible, to overcome this difficulty during the second attempt the sod was cut at the center of the ditch and directly above the dynamite. It was expected that the force of the explosion would throw the top layer of peat over on the bank. However, the result was but little, if any, better than was secured in the first trial because the tangled sod at both sides acted as a hinge. The sod above the dynamite was raised, but it rolled into the ditch again. After this failure a trial was made with the surface of the peat cut at the center and sides of the ditch. The result this time was all that could be expected. It left a ditch having reasonably clean and even bottom and sides. The bottom of the ditch was more uneven than the sides and about 6 in. deeper than the point at which the dynamite was placed. But this is not at all objectionable, for it would soon fill to some extent from the loose dirt left on the sides and bottom. After the first rain the ditch looked to be almost as satisfactory as could be done by hand. The amount of dynamite and time of placing would vary with different types of soil. For this particular work it required 3 lb. of dynamite for each rod of ditch. The labor of cutting the sides of the ditch is also quite a variable factor. There was no absolutely satisfactory method found for cutting through the grass and peat, although a good, sharp spade was fairly efficient. A heavy butcher's cleaver to which is attached a long handle so that both hands could be used ought to make a satisfactory tool for such work.

Better Utilization of Engines and Freight Cars.—In April, 1916, railways operating 227,351 miles of line handled an average of 898,978 ton miles of freight with each freight locomotive in service. In April, 1917, the same roads handled an average of 1,019,405 ton miles of freight per locomotive, an increase of 13.3 per cent. The same roads in April, 1916, handled 12,231 ton miles with each freight car in service. In April, 1917, they handled 13,848 ton miles with each freight car in service, an increase of 13.2 per cent. The returns for May cover only railways operating 173,106 miles of line, but they show the same general improvement. These roads in May, 1916, handled an average of 1,043,709 ton miles of freight with each freight locomotive in service, and in May, 1917, an average of 1,205,852 ton miles; an increase of 15.5 per cent. The same roads in May, 1916, handled an average of 14,115 ton miles with each freight car in service and in May, 1917, they handled an average of 16,098 ton miles, an increase of 14.1 per cent.

President Wilson has signed the Rivers and Harbors bill appropriating approximately $27,000,000.

Construction Features of Rockwood Intake Gates of Imperial Valley Irrigation District

In order to increase its water supply the Imperial Valley Irrigation District is now constructing new intake gates below Yuma, Ariz. These gates will take water from the Colorado River into the main canal entering the Imperial Valley. The structure will be 742 ft. long and will include a deep section 60 ft. wide and 240 ft. long, with a base elevation of 95.5 (Imperial irrigation datum), and a shallow section 45 ft. wide and 382 ft. long, with a base elevation of 104. On each end there will be abutment wings 60 ft. in length. The floor is 2 ft. thick, and is very heavily reinforced. There is a curtain wall 2.5 ft. wide and 8 ft. deep running completely around the structure, making the deepest excavation stop at elevation 85.5. Mean low water in the Colorado River is at elevation 108, and during the high water of early summer the river reached an elevation of 120. At this period the contractor worked at times under a 35-ft. head of water, with a bank of dirt 50 ft. wide between the excavated hole and the river.

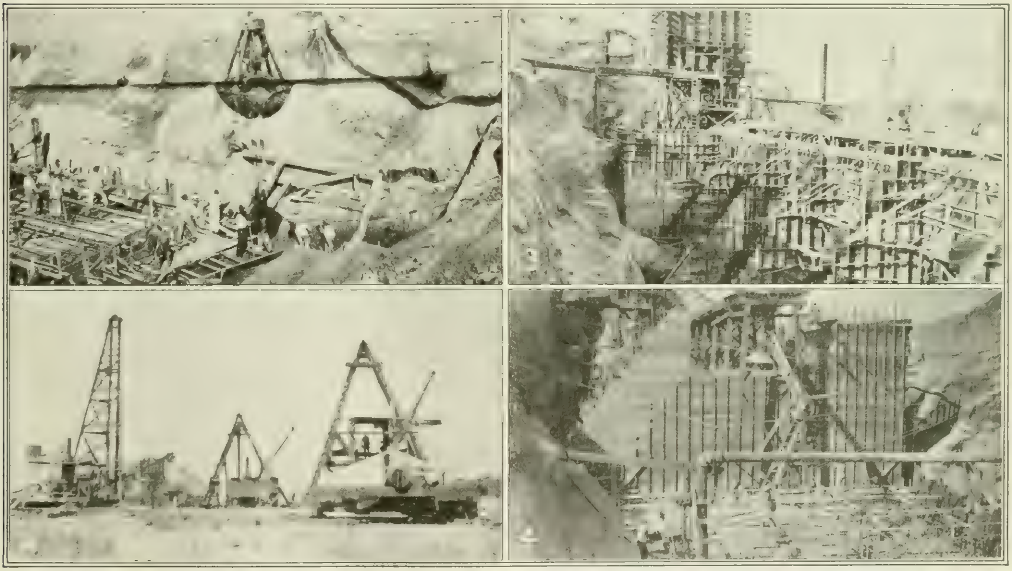
The character of the ground in the deep section was such that the banks stood up well. In fact, it was necessary to shoot in order to dig with an orange peel bucket. No sheeting was required on this section, but in the shallow section soft sand and silt were encountered, necessitating the driving of 9-in. Wakefield sheetpiling on the concrete line. This piling will be a part of the permanent structure to prevent scouring.

The water encountered in the excavation is drained to a cribbed sump placed just outside of the concrete line on the river side of the structure. The sump is unwatered by means of a 12-in. centrifugal pump, driven by a 100-H.P. motor. This pump has been run continuously day and night since its installation on April 20.

The dirt from the inside lines of the structure has been excavated with an orange peel bucket and stiff leg derrick using steam power. The spoil was thrown onto the bank with this outfit and rehandled from there into the river with a clam shell bucket and a gravity rigged derrick equipped with a 30-H.P. Sampson gas engine.

The gate walls are 8-ft. centers and 18 in. thick. In constructing them the forms were not wired, but were braced. On account of the walls being all on the same centers, this bracing could be used repeatedly.

The concrete is poured through Insley chutes from Insley side dump cars operated on a track built on a trestle running the full length of structure on center line. The cars are propelled by an endless cable running over the drum of a Mundy steam swing engine. The concrete mixer is a Ransome of 1 cu. yd. capacity, driven by steam, and dumps directly into the Insley cars. The sand and gravel are fed to the mixer by gravity from a bunker of 400-yd. capacity.



(1) Foundation Excavation and Concrete Work for Floor. (2) Arrangement of Derricks for Excavating and Rehandling Spoil. (3) Storage Bin and Concrete Plant. (4) Spouting Concrete for the Floor.

The cement is brought to the mixer from the store sheds, which are adjacent to the work, on small cars which are also propelled by an endless cable. A very fine quantity of bank gravel was found on top of the low hills surrounding the structure and this gravel is recovered, using a light 1-yd. clam shell bucket, and a small stiff-leg derrick. It is then put through a revolving motor-driven screen and the sand and gravel, properly graded, are taken in Koppel cars to the storage bunker which is partitioned off, one-third for sand and two-thirds for rock.

The work calls for the expenditure of about $265,000 and requires 8,500 cu. yd. of concrete, 365 tons of reinforcing steel, 10,000 cu. yd. of riprap and 165,000 cu. yd. of excavation. The Rockwood intake gates are being constructed by the Ross Construction Co., with R. T. English as Superintendent of Construction.

Effect of Shape of Cutting Edge on Cutting Speed and Wearing Qualities of Drill Bits

Many different shapes of drill bits are in use with hammer drills, but little definite information is available whereby to judge which one of these shapes is best. An investigation to determine the effort of the shape of the cutting edge on the cutting speed and wearing qualities of drill bits has been made recently by Prof. Carroll R. Forbes and Joseph C. Barton. The results of the tests are given by them in a paper prepared for presentation at the October, 1917, meeting of the American Institute of Mining Engineers, and printed in the August Transactions of the Society. An abstract of the paper follows:

The bits tested were those in common use, namely, the 4-point or cross bit, the 6-point bit, the Z bit and the "Carr" bit. The rock in which the tests were made was the red granite from southeast Missouri. It is a coarse crystalline granite containing an unusually large amount of quartz and is extremely hard, and on account of its uniform texture is admirably adapted to this work. While tests in other rocks might show somewhat different results, nevertheless it is the opinion of the authors that the relative cutting quality inherent in the shape of the bits would be the same in all rocks. Other qualities, such as mudding freely, freedom from fitchering, etc., might make one bit more desirable that another in softer rocks.

The 4-point bits were the usual shaped bits commonly made on the Leyner sharpener with 14° taper on the wings and a 90° angle between cutting edges. Some tests were run at 85 lb. pressure with a 4-point bit made with a 5° taper on the wings. This was made by using the Carr bit die.

The 6-point bits were the usual shaped bits made on the Leyner sharpener.

The Carr bits were made with a 5° taper and an angle of 100° between cutting edges.

The Z bits were made with the regular Z-bit dolly which makes an angle of about 60° in the center and an agle of about 45° on the outer cutting edge. The center is made slightly higher than the outer edges. The Carr bit discs were used in forming Z-bits to give them a 5° taper. The Z-bit dolly was for solid steel, so it was necessary to drill out the center hole.

Several Z bits were tested at 85 lb. pressure, that were filed and hammered down, to give an angle of about 100° on the center edge and 65° on the outer edges.

The holes in the center of the bits were the ordinary size with the 4-point and 6-point and Carr bits. The hole in the Carr bit was much larger than those used in the others. A hole of the same size as in the Carr bits was used in the Z bit.

All tests were made with an Ingersoll-Rand "Jackhamer" drill. In the "down-hole" tests the drill was weighted with a 94-lb. weight, thus insuring a constant pressure on the bit.

Most of the tests were made in vertical "up-holes," great care being taken to see that the drill was vertical. The tests consisted of drilling into a large block of granite supported on stringers over a concrete-lined pit. For this work the drill was mounted on an air feed, which, however, was not large enough to produce the required pressure on the bit, so that it was necessary to counter-balance the weight of the machine by a bucket loaded with 40 lbs. of scrap iron and connected to the machine by a rope over an overhead pulley.

Every effort was made to insure uniform conditions and to have the drill bit the only variable.

A uniform air pressure was obtained by having a "pop-off" valve on the air receiver, which was connected by a 1-in. hose to the drill. The air compressor was regulated to supply sufficient air to keep the pop-off valve open and the drill running at the same time, the gage pressure remaining constant. The air receiver was drained after every third steel, as it was found in former work that this factor greatly influenced the quality of the air supply.

Uniform lubrication was insured by oiling the drill after each 1-minute test. The drill was taken apart and thoroughly cleaned and oiled after every third steel.

The steel used was all of the same kind, F J A B⅞-in. hollow hexagon, and all comparative tests were run with steel of practically the same length. Lengths of 24, 48 and 62 in. were used.

The greatest source of error in work of this kind is in the making and tempering of bits. It is impossible to make these conditions entirely uniform and many tests were made and the results discarded, because of non-uniformity in tempering. Any bit with a corner off, or which was chipped in any way (except the Z bit in a few cases), or which showed signs of being too hard or too soft, was rejected and resharpened until a perfect temper was obtained.

All bits were made and sharpened in a Leyner-Ingersoll 5-A sharpener. The bits were heated, both for sharpening and tempering, in a gas muffle. In sharpening and tempering the following rules were observed: (a) Heat to the usual working heat, taking care to see that the bit is heated uniformly throughout, and making as few heats as possible. (b) Heat only the end of the bit. (c) Never submerge a bit entirely under water until cold. (d) Keep shank end square. (e) Never let scale form by too much air. (f) When worked put in lime to anneal. (g) Heat the bit up at least 800° and be sure to leave it in the furnace long enough to heat to the center; then draw from the fire and place in some dark chamber (tile, etc.), so the color can be observed, until the steel has cooled to about 800°; then dip into Sentinel paste which has melting point of 775° C., and let white residue form on the bit; place in the furnace immediately. The white residue should melt the instant the bit is inserted into the fire again; if it does not melt at once, reheat and repeat the operation.

The Sentinel paste is a trade composition consisting of molecular mixtures of metallic salts which melt at predetermined temperatures. The finely ground salts are mixed with paraffin wax. Before using it is heated gently so as to just melt the wax and reduce it to the consistency of thick paint, so it can then be streaked or painted on the work in the cold, or, as in the present case, the work is covered with a thin film of paste by dipping in the paste while the work is at a temperature above the melting point of the salts. When the wax carrying the Sentinel powder burns off, it leaves behind a layer of white salt, and upon the desired temperature being attained, the salt fuses and disappears, or, on a reduction of temperature the paste reappears as a white coating. After the bit is put in the furnace and the white residue melts instantly, plunge the bit into cold water to about ¼ to ½ in.

All bits in these tests were plunged into water as described above and slowly moved about in the water until fairly cool; then the steel was left in water until cold.

Experiments with Down Holes.

The first series of tests was made in down holes. The purpose of these tests was to ascertain the effect of gage or diameter of bit on cutting speed. It was necessary to find this relation in order to compare different bits by reducing them to the same gage.

All tests were made in shallow holes, about 1 ft. in depth, so that the cuttings could be easily blown from the hole. Down-hole tests were made only with the 4-point bit and at a pressure of 95 lb. In most cases, five 1-minute runs were made with a bit. About 30 tests were made altogether.

A curve was plotted assuming that the cutting speed varies inversely as the square of the diameter. The first point on the theoretic curve was taken at gage 1.3 and speed 4.3, and the curve plotted accordingly. The results of the second test were then plotted in the same scale, the points falling close to the curve. The second test was taken as being the most representative. Points plotted from the third and fourth tests fell close to a similar curve. In order to compare cutting speed of different gages, every condition, including depth of hole, etc., must be uniform, and it would not be fair to compare the speed of a new bit with the speed of the same bit when run to a smaller gage. From this curve it is evident that for small gages the cutting speed varies inversely as the square of the diameter of the bit. For large gages the results do not seem to check so well, and from results obtained in former work by H. Vogel, the relation of the 3/2 power was obtained, which may apply to larger gages.

Results from Up Holes.

Three different pressures were used in drilling the up holes, 95 lb., 85 lb. and 70 lb. Most of the tests were made at the 95-lb. pressure. Nearly 200 different tests were made in all.

All holes were first collared to about ½ in. depth; the bit to be tested was then run at a low pressure for about 6 seconds. The bit was then taken out, the gage and the depth of hole measured, and the test was ready to start. One-minute runs by stop watch were made. All bits were run for four 1-minute tests and in a few cases six or eight 1-minute runs were made. No attempt was made to run each bit to its full extent, although in most cases at the end of four runs the cutting speed had materially diminished. The bits, however, probably would have drilled several inches farther, and in the case of the Carr bit, considerably farther. The life of bits seems to be the same at all pressures. That is, they will drill a certain distance and no more, no matter what the pressure is.

TABLE I.—SUMMARY OF RESULTS AT 95 LB. PRESSURE.

Reduced to uniform gages, assuming speed varies as $\frac{1}{D^2}$.

	Kind of Bit.	Avge. Diam., In.	Avge. Dist. Drilled.	Avge. Speed per Min.	Avge. Initial Speed.	Avge. Final Speed.	Avge. Loss in Gage per In.
A	4-point starter	1.880	8.85	2.212	2.500	1.962	0.0110
B	4-point second	1.652	11.50	2.865	3.683	2.100	0.0108
C	4-point third	1.385	15.41	3.853	4.800	3.062	0.0068
	Reduced to uniform diameter						
	From A	1.750	.....	2.554			
	From B	1.750	.....	2.552			
	From C	1.750	.....	2.415			
		1.750	.....	2.507	Average of 4-point		
A	6-point starter	1.869	7.36	1.852	2.200	1.537	0.0189
B	6-point second	1.662	10.07	2.519	2.812	2.175	0.0109
C	6-point third	1.426	10.85	2.713	3.112	2.200	0.0063
	Reduced to uniform diameter						
	From A	1.750	.....	2.112			
	From B	1.750	.....	2.271			
	From C	1.750	.....	1.802			
		1.750	.....	2.062	Average of 6-point		
A	Carr bit second	1.535	12.42	3.109	4.025	2.775	0.0028
B	Carr bit third	1.605	13.37	3.345	3.500	2.875	0.0032
	Reduced to uniform diameter						
	From A	1.750	.....	2.394			
	From B	1.750	.....	2.488			
		1.750	.....	2.441	Average Carr bit		
A	Z bit second	1.609	9.72	2.429	3.275	1.925	0.0104
B	Z bit third	1.447	12.87	3.212	3.850	2.600	0.0049
	Reduced to uniform diameter						
	From A	1.750	.....	2.053			
	From B	1.750	.....	2.196			
		1.750	.....	2.130	Average Z bit		

Table I represents the summary of average results and also the same averages reduced, for the purpose of comparison, to uniform diameters by assuming that the cutting speed varies inversely as the square of the diameter.

It will be seen from these results that the comparative cutting speeds of the different bits at this pressure are as follows:

(1) 4-point (gage 1.75)...........2.51 in. per minute
(2) 6-point (gage 1.75)...........2.06 in. per minute
(2) Carr (gage 1.75)............2.44 in. per minute
(3) Z (gage 1.75) ....2.13 in. per minute

At this pressure the 4-point bit cuts slightly faster than the Carr. It was very difficult to make the Z bit hold up at all on the high pressure, as the corners would invariably chip off.

Table II shows the final average of the results reduced to the three different gages by the square of diameter.

Theory of Drilling Rock.

According to B. F. Tillson, "when rock is excavated by a drill bit three applications of forces seem to be involved—by abrasion, by crushing, and by severing or chipping. Although all of these must take place to a certain degree, the greatest amount of useful work is performed when the percentage of force applied to chip reaches a maximum." According to this theory, the screen analysis of cutting ought to show the most efficient bit. Samples were taken from the up holes when drilling at 95 lb. pressure, from which the screen analyses were made. Screening was done in Tyler Ro-Tap apparatus. The samples were taken near the first part of a run with each bit. Some of the dust was lost in taking the sample, but as much as possible of the entire sample was saved.

The 6-point bit produced the finest cuttings, the Z bit the next finest, the Carr next and the 4-point the coarsest. This corresponds to the relative cutting speeds, the 6-point slowest, the Z next, the Carr next and 4-point fastest. In order to study further the cutting action of the different bits, four shallow holes

TABLE II.—COMPARATIVE CUTTING SPEEDS OF DIFFERENT BITS.

Reduced to uniform diameters, assuming speed varies $\frac{1}{D^2}$.

Kind of Bit.	Reduced Gage, Inches.	Average Speed per Min., 95 lb. P.	Average Speed per Min., 85 lb. P.	Average Speed per Min., 70 lb. P.
4-point	2.00	1.92	1.39	0.85
6-point	2.00	1.59	1.23	0.68
Carr	2.00	1.87	1.56	1.16
Z	2.00	1.63	1.51	1.16
Z flat angle	2.00	....	1.54	....
4-point 5° taper	2.00	....	1.39	....
4-point	1.75	2.51	1.81	1.11
6-point	1.75	2.06	1.61	0.88
Carr	1.75	2.44	2.03	1.51
Z	1.75	2.13	1.97	1.51
Z flat angle	1.75	....	2.01	....
4-point 5° taper	1.75	....	1.81	....
4-point	1.50	3.41	2.47	1.51
6-point	1.50	2.82	2.19	1.20
Carr	1.50	3.32	2.77	2.06
Z	1.50	2.90	2.69	2.06
Z flat angle	1.50	....	2.74	....
4-point 5° taper	1.50	....	2.47	....

about 1 in. deep were drilled beside each other under the same conditions and using 85 lb. pressure.

A study of the bottoms of the holes revealed the fact that the 6-point hole was perfectly smooth, the 4-point nearly as smooth, the Z bit and Carr bit holes were quite rough, the Carr bit having a conical shaped projection in the center due to the large hole in the bit. The relative cutting speeds at 85 lb. pressure were as follows: 6-point, 4-point, Z and Carr, which corresponded with the apparent roughness of the bottoms of the holes.

The use of the large hole in the center of the Carr bit is evidently one of its advantages and the same idea could be applied to advantage on all other bits. The advantage of the large hole is that it leaves a center core and diminishes the cutting surface.

CONCLUSIONS: COMPARATIVE MERITS OF EACH TYPE OF BIT.

Cutting Speeds.

	95 lb.	85 lb.	70 lb.
(1)	4-point	Carr	Z bit
(2)	Carr	Z	Carr
(3)	Z	4-point	4-point
(4)	6-point	6-point	6-point

From the above comparison, the 6-point bit is evidently slower drilling under all conditions. The 4-point, although ranking first at 95 lb. pressure, under ordinary conditions would drill less rapidly than either the Carr or Z. In comparison with the others, the Z bit apparently increases in cutting speed as the pressure is decreased. This would indicate that the Z bit would be quite efficient in soft rock or at lower pressures, but it is evidently not adapted to extreme high pressures in hard rock. From the standpoint of cutting speed, the Carr and Z bits are the most efficient.

Loss of Gage.

The average loss in gage per inch was as follows:

4-point	seconds	0.010
4-point	thirds	0.007
6-point	seconds	0.010
6-point	thirds	0.007
Z bit	thirds	0.004
Carr bit	seconds	0.003
Carr bit	thirds	0.003
4-point	5° taper thirds	0.004
Z bit	filed	0.003

This loss is almost constant at all pressures. It will be seen from these figures that the loss in gage with 4 and 6-point bits is considerably more than with Z or Carr bits, and that the 5° taper on a 4-point bit greatly diminishes the loss of gage.

From the standpoint of loss of gage, the Carr, Z bit and 4-point bit with a 5° taper, are superior to others. This factor is one that is often overlooked, and the great advantage of using a bit that loses little in gage is not generally considered. As an example the following calculation has been made:

Drilling Time.—Drilling time for 6-ft. hole in granite, 1½-in. diameter at bottom. Length of changes, 1 ft. Difference in gages, 1/16 in. with Carr and Z bits, ⅛ in. with 4-point and 6-point bits.

CARR.

Length of Steel.	1 Ft.	2 Ft.	3 Ft.	4 Ft.	5 Ft.	6 Ft.
Gage in sixteenths	1 14/16	1 13/16	1 12/16	1 11/16	1 10/16	1 9/16
Gage in tenths	1.875	1.812	1.750	1.688	1.625	1.562
Distance per minute	1.771	1.897	2.034	2.186	2.352	2.554
Minutes for each foot	7.340	6.270	5.890	5.190	5.102	4.700

Time 34 min. 49 sec. for 6 ft.

Z BIT.

Gage	1.875	1.812	1.750	1.688	1.625	1.562
Distance per minute	1.723	1.839	1.978	2.126	2.295	2.484
Minutes for each foot	6.960	6.530	6.070	5.640	5.230	......

Time 35 min. 16 sec. for 6 ft.

4-POINT.

Gage	2¼	2⅛	2	1⅞	1 6/8	1⅝
Distance per minute	1.005	1.230	1.389	1.580	1.814	2.104
Minutes per foot	11.890	9.760	8.640	7.590	6.620	5.700

Time 50 min. 12 sec.

6-POINT.

Gage	2¼	2⅛	2	1⅞	1 6/8	1⅝
Distance per minute	0.976	1.092	1.235	1.405	1.613	1.867
Minutes per foot	12.295	11.000	9.700	8.540	7.440	6.430

Time 55 min 21 sec. 6-ft. hole.

From these calculations the Carr and Z bits apparently save one-third in drilling time over the 4 and 6-point bits. This is due more to the fact that smaller gages can be used than to greater cutting speed. The calculations were based on actual cutting speeds and loss in gage shown in tests.

Breakage and Ease of Sharpening and Tempering.—There is little difference between the 4-point and 6-point bits in respect to ease of sharpening and tempering.

The Z bit is more easily made, but it is very difficult to temper so that it will stand up under high pressure. This is on account of the weakness of the outer cutting edges.

The Carr bit is by far the easiest of all to make and temper and can be tempered much harder than others.

Summary.

The results in down holes indicate that the cutting speed varies inversely as the square of the diameter, at least for smaller gages.

Drilling speed increases almost uniformly with increase in pressure. A pressure of about 85 lb. per square inch seems to be best adapted to all bits for drilling in rock of the hardness of that used in the tests.

Speed of drilling seems to be proportional to the coarseness of the cuttings as shown by screen analysis and study of the bottoms of the drill holes.

Taking into consideration its cutting qualities, loss in gage, ease of making and tempering, the Carr bit seems to be far superior to all others, except possibly the Z when used at low pressures.

The Z bit at low pressures and probably in soft rock would equal if not surpass the Carr bit in cutting speed, but on account of the difficulty in its making and tempering, it is doubtful whether it would be as desirable under any conditions as the Carr.

For exceedingly high pressures in very hard rock, the 4-point bit made with a 5° taper on the wings seems to be superior to all others.

The 6-point bit apparently has little to recommend it under any circumstances, although it is convenient to use in starting holes.

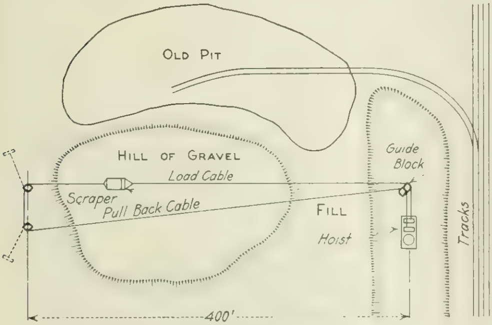
Treatment for Summer Sores on Horses

Many horse owners find that in summer their horses are troubled by sores which resist usual methods of treatment. As cool weather approaches healing frequently takes place, but there always is the possibility of the wound breaking out anew with the advent of warm weather. Numerous methods of treatment have been tried with varying results. According to the July Reclamation Record, the following treatment in many cases has brought good results:

The wound is thoroughly scraped with a surgeon's sterilized curette, or with a clean, disinfected dull knife, after which it is showered with cold water for 10 to 15 minutes. Iodoform is then dusted on and rubbed into the wound by means of a wad of absorbent cotton, and the wound is immediately covered with a layer of collodion. The iodoform and collodion applications are repeated every 24 hours for 15 days or until the sores heal. Ether or chloroform may be used in place of iodoform, being poured on cotton and applied to the sore for two minutes before painting it with collodion. Formalin has been used by injecting it into the tissues. This, however, should be used only by a qualified veterinarian as its improper use might cause severe sloughing and disastrous results.

Overburden Stripping with Bottomless Bucket

An improved method of removing the overburden from a hill to get at the sand and gravel underneath, is being employed by the Diamond Sand & Gravel Co., at Bedford, O. The top of the hill is being scraped off and deposited in a ravine at one end of the hill. The accompanying sketch shows the layout of the installation.



Sketch Showing Method of Stripping.

The scraper is a 1-yd. Sauerman bottomless power scraper operated by a 90-H.P. Thomas electric hoist, which is set up on high ground across the ravine. The hoist is a type specially designed for scraper work, the rear drum operating the "pull-back" cable having a speed three times as great as the front drum. The machine requires one operator and a rigger stationed at the guide blocks to make the necessary shifts in the line of operation. This outfit installed represents an investment of about $5,000.

Power Scraper Cutting Off Top of Hill.

The top soil of the hill is largely clay and runs from nothing to 6 ft. in depth. Hard "shoulders" of clay, when encountered, are removed by "sawing" the scraper back and forth over the obstruction. A day's output will fluctuate between 200 and 300 yd., depending on the nature of the material.

The contract for constructing the new union depot and terminal yards at St. Paul, Minn., has been awarded to Morris, Shepard & Dougherty and George J. Grant Construction Co. This work will involve an expenditure of about $11,000,000.

Classification of Permissible Explosives by U. S. Bureau of Mines

A new list of permissible explosives has been issued by the U. S. Bureau of Mines. It contains the brand names of 152 explosives, all of which were tested by the Bureau prior to Jan. 1, 1917. In the new list the permissible explosives are classified in two ways: (1) On the basis of the volume of poisonous gas produced by 1½ lb. of the explosive, and (2) on the basis of the characteristic ingredient of each explosive. These classifications are described as follows in Technical Paper 169 of the Bureau:

Volume of Poisonous Gases.—Most permissible explosives when properly detonated in a drill hole in a coal mine produce poisonous gases, but they produce at the same time a much larger volume of non-poisonous gases. In order that the poisonous gases may not under normal conditions become a menace to the lives or health of miners no explosive is now or can become permissible if it evolves upon detonation more than 185 liters (5½ cu. ft.) of permanent poisonous gases, as determined by test in the Bichel pressure gage. Field tests of an explosive made under extreme conditions for the production of the greatest percentage of poisonous gases in the air show that in a narrow entry, with no ventilation at or near the face, a 1½-lb. charge of an explosive, which gave 158 liters of poisonous gas in gage tests, produced 0.18 per cent of carbon monoxide (the only poisonous gas present) in the air when the sample was taken 2 minutes after the shot. Another sample of the air taken 2 minutes later contained 0.08 per cent of carbon monoxide. It is therefore evident that where ventilation is not active, as in a closed heading, miners or shot firers should not return to the face until at least five minutes after a shot. At all working faces that are difficult to ventilate explosives of class A or class B should be used, preferably those of class A.

The classification on the basis of the volume of poisonous gases produced by 1½ lb. of the explosive is as follows:

Class A, those explosives from which the volume of poisonous gases produced is not more than 53 liters.

Class B, those explosives from which the volume of poisonous gases is more than 53 liters but less than 106 liters, inclusive.

Class C, those explosives in which the volume of poisonous gases is more than 106 liters but less than 158 liters, inclusive.

Characteristic Ingredients.—Explosives are classified in accordance with their characteristic ingredient as follows:

Class 1, ammonium nitrate explosives.—To class 1 belong all the explosives in which the characteristic ingredient is ammonium nitrate. This class is divided into two subclasses. Subclass A includes every ammonium nitrate explosive that contains a sensitizer that is in itself an explosive. Subclass B includes every ammonium nitrate explosive that contains a sensitizer that is not in itself an explosive. The ammonium nitrate explosives of subclass A consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitrosubstitution compounds which are used as sensitizers. The ammonium nitrate explosives of subclass B consist principally of ammonium nitrate with small percentages of resinous matter or other nonexplosive substances used as sensitizers.

Ammonium nitrate explosives, when fresh and properly detonated, are well adapted for use in mines that are not unusually wet. They are not suitable for use in wet mines, for if the contents of a cartridge of ammonium nitrate explosive is exposed for only a few hours to the damp atmosphere the explosive may so deteriorate as to fail to detonate completely, because ammonium nitrate takes up moisture readily. The redipping of cartridge of ammonium nitrate explosives aids in protecting the contents against moisture, or moist air, and the cartridges should be so stored and handled as to preserve the efficacy of the paraffinlike coating. The explosives should be obtained in a fresh condition and purchased in such quantities as will permit their prompt use. Experience at the Pittsburgh experiment station of the bureau shows that ammonium nitrate explosives will usually detonate completely after storage for 6 months in a well-ventilated magazine.

Class 2, hydrated explosives.—To class 2 belong all explosives in which salts containing water of crystallization are the characteristic ingredients. The explosives of this class are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are easily detonated, and most of them can be used successfully in damp working places.

Class 3, organic nitrate explosives.—To class 3 belong all the explosives in which the characteristic ingredient is an organic nitrate other than nitroglycerin. The permissible explosives now listed under class 3 are nitrostarch explosives.

Class 4, nitroglycerin explosives.—To class 4 belong all the explosives in which the characteristic ingredient is nitroglycerin. These explosives contain free water or an excess of carbon, which is added to reduce the flame temperature. A few explosives of this class contain salts, or an unusually low percentage of nitroglycerin, that reduce the strength and shattering effect of the explosives on detonation. The nitroglycerin explosives have the advantages of detonating easily and of not being readily affected by moisture.

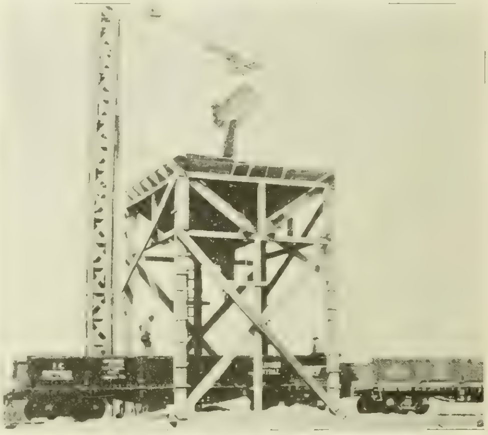
Mixture of Cinders, Sawdust and Manure Stops Leaks in Masonry Wall

In widening the Louisville & Portland Canal at Louisville, Ky., the old canal wall formed part of the cofferdam. The wall was of stone masonry and had a considerable number of open joints and deep holes, through which much water entered the pit. The minor leaks through the wall were stopped by causing a mixture of fine cinders, sawdust and manure to be drawn into the open joints from the canal side of the wall. This material was placed in a small wooden box with one side open and the bottom perforated. The open side of the box was held against the canal side of the wall, causing the water to flow through the perforations and carry the mixture into the open joints. The depth to which the box was submerged was determined by locating the inflow of water from the rear of the wall. A foreman and six men were detailed to attend to this work. The success attained in preventing leakage by this method was such that during ordinary river stages one 12-in. centrifugal pump kept the pit unwatered.

Railroad Ballast Digging and Loading Plant

A well designed and economical plant for digging and loading railroad ballast in one operation is being operated by the Neal Gravel Co. at Palestine, Ill. The company is a large producer of sand and gravel and has two washeries in operation in Indiana, but the Palestine plant is devoted solely to furnishing ballast for Illinois Central R. R. track operations.

With a 2-yd. Sauerman dragline cableway excavator gravel is excavated from the pit alongside the siding, conveyed to, and dumped into the hopper which straddles the track. The digging range of the excavator is 500 ft. When the pit is cleaned up within a 500-ft. radius, the hopper and the cableway mast will be moved and the siding extended so as to open up a new section of the pit.



Railroad Ballast Plant at Palestine, Ill.

This plant complete with 2-yd. Sauerman bucket, cableway, cableway fittings, 64-ft. mast, overhead hopper with standard railway clearance, 10x12 Thomas hoist and 60-H.P. boiler, cost about $11,000 installed. Operating 10 hours a day, it has delivered an output of 655 cars or 15,720 yd. a month. The operating force consists of one engineer, fireman and three men "spotting" cars.

Plans are now before Parliament for the aquisition of the Canadian Northern Ry. by the Government. This road with the Intercolonial Ry., now owned by Canada, would give the Dominion a state owned coast to coast line. The Canadian Northern Ry. has 9,000 miles of line and the Government is stated to own $60,000,000 of its $100,000,000 capital stock.

The Great Northern Ry. has started work on the construction of extensive yards at St. Paul, Minn., to take the place of those on the site sold to the Union Depot Co. The new yards will require the razing of many buildings, including 250 residences, 40 stores, 5 schools and 3 churches. There also will be about 1,000,000 cu. yd. of earth and rock work.

The citizens of St. Louis, Mo., will vote Nov. 6 on an $18,840,000 bond issue for public improvements. Of this amount $9,915,000 is for carrying out the River des Peres project.

Methods and Costs in Driving the Pine Mountain Tunnel

Work is now under way on the driving of an 8,700-ft. tunnel in Marin County, California, for the Marin Municipal Water District. The tunnel is of horseshoe section, 8 ft. x 8 ft. net, inside of concrete lining. Of the total length about 600 ft. near the two portals will have a 12-in. concrete lining, and the remaining 8,100 ft. a 6-in. lining. The quantities per lineal foot are as follows: Excavation, 3 cu. yd.; concrete in 6-in. lining, 0.6 cu. yd; concrete in 12-in. lining, 1.2 cu. yd The actual quantities of concrete will be about 35 per cent greater on account of overbreakage. The methods employed in driving this tunnel are described by Mr. H. Devereux in a recent issue of the Mining and Scientific Press, from which the following notes are taken:

The contract was awarded early in December, 1916, to McLeran & Peterson, of San Francisco, at $257,400 for the entire work, or $29.70 per lin. ft. for driving and lining the tunnel. Work was commenced in the middle of December. Hand-drills were used until about Feb. 1, machine-drills since that time. The actual cost of driving has been about the same for both methods, but the machine work is much more rapid. Up to May 15 about 2,000 ft. of progress was made on the east end, and 1,000 ft. on the west end. Concreting commenced about June 1. The maximum progress in driving for any one month has been 568 ft. in the east heading, or 19 ft. per day. The average progress since the machine drills were installed has been 13 ft. per day in the east end, and 10 ft. in the west end.

The power-plant for the tunnel is about 3 miles west of Fairfax. The east portal is about 1,000 ft. from the power-house. The west portal is nearly two miles southwest from the power-plant. The compressor-plant consists of three 25 H.P. Fairbanks-Morse Y-type semi-diesel engines, and three 8 by 8-in. Sullivan compressors. The pressure maintained at the compressor is 100 lb. per sq. in. Air is conveyed through a 3½-in. pipe, 1,000 ft. to the east portal and 10,000 ft. to the west portal. Three hundred cubic feet of free air per minute are supplied, which is sufficient to run three drills and also the forges. The loss of pressure at the west end does not exceed 2 lb.

Three No. 18 Leyner drills with a 1¼-in. chuck, 24-in. feed, and six sets of 1¼-in. hollow steel from 24 in. to 96 in. long are used. There is an 18-gal. water tank and an air line manifold. The drills are mounted on horizontal bars. Jackhamers are used for trimming. The duty of the No. 18 Leyner drill in this tunnel is 5 ft. of hole per hour using 1,000 cu. ft. of free air at 100 lb. pressure per lineal foot of hole drilled. The cost of drilling including bonus is 20 ct. per foot. This estimate allows for delays.

The cost of fuel and lubricating oil for a 135-day run was as follows:

11,000 gal. fuel-oil, 24 Baumé gravity, at $0.032 per gal., $352.
250 gal. valvoline, strained and used twice, at $1.35, $324.
Hauling, three miles from railroad, at $0.005 per gal., $55.
Total, $731.

The plant was run continuously and 62½ H.P. was developed. This gives a cost of 36 ct. per-horsepower hour for fuel and lubricating oil. This amount of power is sufficient for three drills and two forges. The cost of labor at the power house is $320 per month. During March the total progress in both headings was 854 ft., and the cost for power was $0.65 per ft.—$0.29 for fuel and $0.36 for labor. A 25 H.P. Fairbanks-Morse Y-type engine has just been installed to operate a 220-volt, 25 kilowatt generator, which will be used to run a plant for lighting the tunnel and a rock-crusher for crushing aggregate for the concrete lining.

For ventilation 1,000 ft. of 10-in. pipe has been laid at each heading, reducing to 8-in. for the remainder of the distance. This pipe has been found to be too small and is to be replaced with a 12-in. pipe, using a blower working at a pressure of 4.5 lb. per square inch.

For illumination, acetylene lamps on the men's caps and candles have been used, but as noted above an electric lighting plant has now been installed.

The rock penetrated so far in the east end of the tunnel is sedimentary with intrusive igneous rock. On the west end there is Franciscan sandstone, black serpentine and hard boulders, with some diabase. The rock at the west end is harder than at the east end. The number of holes per round at the east end is 9 to 14, and 14 to 16 at the west end. Six feet of hole is drilled per round, the wedge-cut system of arrangement being used. Forty per cent L. F. gelatine powder is used. In the east end, 9 lb. of powder, 19 ft. of fuse, and 4 caps are used per lin. ft. of progress. In the west end, 15 lb. of powder, 26 ft. of fuse and 4 caps are required.

On the east end there are two drillers and one helper per shift, and one driller and one helper per shift on the west end. Three shifts are worked and as many as five rounds or 30 ft. of progress has been made in 24 hours, requiring 150 ft. of drill-hole per drill for each 24 hours. Four shovelers are employed on a shift in each end, two working at any one time and two resting. They handle from 10 to 15 cu. yd. per man per shift. The shovelers use square-pointed shovels, and shovel from steel floor plates, ¼ in. by 4 ft. by 6 ft.

The material is transported by mules in turn-table end-dump cars of 25 cu. ft. capacity. When the work has progressed so far that mules cannot handle the material economically, it is proposed to remodel White or Stanley steam automobiles to do the hauling. At the east end the material is dumped close to the portal. On the west end it has to be hauled for some distance. The track has an 18-in. gauge and is laid with 27-lb. rails.

So far but little timbering has been required. About 10 per cent of the tunnel has been side and top-lagged, while for about 5 per cent, timber sets in the arch only have been used with the top-segments lagged. In the first 2,000 ft. of tunnel 20,000 ft. B.M. of timber has been used, or 10 ft. B.M. per foot of tunnel.

The overbreakage thus far has been small, not exceeding 35 per cent of the net area of the concrete section. On the east end the ground is being drilled to the full section, on the west end to about 80 per cent of the full section, requiring trimming along the entire length in the latter case.

The following is the scale of wages paid on the Pine Mountain tunnel:

Drillers	$3.75	Dump-men	$3.00
Helpers	3.00	Foremen	6.00
Shovelers	3.25	Compressor-engineers	3.50
Teamsters	3.00	Pipe-men	3.00
Blacksmiths	4.00	Packers	3.00
Helpers	3.00	Common labor	2.50

The maximum monthly progress has been 568 ft. or 19 ft. per day. For this rate of progress, which was at the east end, the cost per lineal foot to the contractor is as follows:

	Per lin. ft.
Drilling	$ 1.67
Shoveling	1.90
Hauling	0.67
Dumping	0.48
Blacksmith	0.37
Pipe-men	0.16

Powder	1.80
Power	0.65
Bonus	2.00
Construction and Maintenance roads and trails	0.25
Teaming	0.30
Packing	0.25
Miscellaneous plant, pipe-line, track	2.00
Heavy plant, engines and compressors	1.00
Drill steel, repairs	0.30
Timbering, material	0.20
Timbering, labor	0.12
Total cost per foot	$16.12

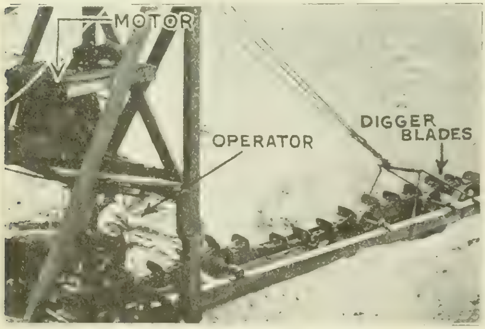
A bonus of $0.25 per man per foot is paid for each additional foot over 14 ft. per day, to all men who remain during the month. The cost at the west end is about the same as at the east end. The rate of progress is less, but on the other hand there is no bonus. Assuming that the excavation runs 3 cu. yd. per lineal foot of tunnel, the cost per cubic yard is approximately $5.40.

Other miscellaneous items are as follows: Cost of camp buildings, etc., $25 per man for a 70-man camp. The cost of laying the 3½-in. pipe for the compressed air line over the mountain was $0.08 per ft. for distribution, and $0.04 for laying, a total of $0.12. The cook-house, caring for 40 men, uses 1 bbl. fuel-oil in 8 days.

Sand Digging Device

A practical device for digging sand from banks which are almost entirely free from gravel is here illustrated.

The digging is done by an excavator boom made of heavy timbers with sprockets at either end on which runs an endless chain. Steel blades are mounted on the chain and the weight of the heavy boom presses these blades into the sand. The revolving blades drag the sand into the field end of an Imperial belt conveyor which carries the material to the screening plant.



Device for Digging Sand from Banks.

The excavator boom is hinged to a canvas-covered frame, which houses the operator and the electric motor which drives the endless chain. A reel on which is wound a cable running to the outer end of the boom enables the operator to raise or lower the boom.

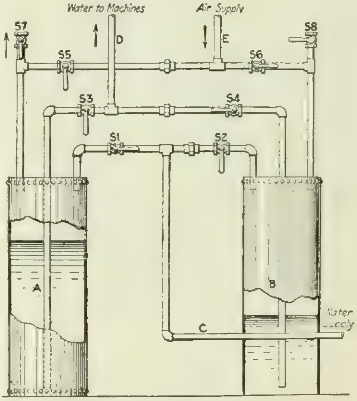
A workman with a shovel works high up on the side of the pit to keep the material sliding down to the digger. If the sliding sand comes too fast and buries the excavator boom, the operator simply reels in the cable until the boom again rests upon the surface.

The photograph accompanying this description was taken at the pit of the Wilcox Co., Janesville, Wis., and this particular machine was constructed by Mr. Julius Mosser, superintendent of the Wilcox plant. Diggers of similar type are in use in other Janesville sand pits.

Water Supply for Drilling at Same Pressure as Compressed Air

A tank arrangement that assures the drill-runner a steady supply of water having the same pressure as the compressed air, is discribed in the July Compressed Air Magazine by Mr. H. H. Hodginson, Mining Engineer. Two tanks are necessary; while one is supplying water the other is being filled. It is also necessary to have a supply of water to be piped to the tanks having a head of at least 5 ft., so that the water will flow into the tanks and overcome the friction of the connections. The arrangement is shown in the accompanying illustration.

The two tanks A and B are standard stock galvanized iron tanks made by any of the large drill manufacturers and have three holes in the top tapped for standard ¾-in. pipe fittings. Into these holes ¾-in. pipe is inserted, as shown, with the required unions, elbows, tees and eight ¾-in. stop-cocks. Stop-cocks are preferable to valves as they can be opened or closed more readily, show at a glance whether they are open or closed, because of the position of the handle, and are less expensive.



Arrangement of Water Tank.

The operation of the tanks is as follows: Assuming tank B supplying water to the drills, stop-cock S_2 and S_8 are closed while S_4 and S_6 are open, allowing water to pass through pipe D and air through pipe E, respectively. In the meantime water is passing through pipe C into tank A and the stop-cocks S_1 and S_7 are open. S_7 is to allow the air to escape from the tank as the water flows into it through S_1. Stop-cocks S_5 and S_3 are closed. When tank B is empty S_6 and S_4 are closed while S_8 and S_2 are opened, which permits the water from C to fill it. By closing S_7 and S_1 and opening S_3 and S_5 tank A will now supply the water.

As the heading advances, pipe may be inserted between the tanks and the machines instead of moving the tanks each time. It is not necessary to remove the tanks when blasting the headings if they are placed at a safe distance.

Owing to the scarcity of railroad work many railroad contractors are now engaging in coal stripping operations in the coal fields of Eastern Ohio and Western Pennsylvania. In several cases where the overburden is light the contractors are using their railroad type of shovels and hauling the material to spoil banks.

Method and Cost of Repointing Sea Wall With Cement Gun

A cement gun was used for repointing about 22,000 lin. ft. of joints in the west side of the Government sea wall at Governors Island, N. Y. The work is described by Mr. Henry W. Babcock, U. S. Assistant Engineer, in the July-August Professional Memoirs, from which the following notes have been taken:

The sea-wall is built of heavy stones laid in courses; none of the courses were required to be of uniform height throughout except the coping, which was 1 ft. high and 3 ft. wide. The joints were ordinarily 1 to 1½ in. thick, sometimes reaching 2 in. On the northwest, or Hudson River, side of the wall the mortar had come out of the joints, almost generally, indicating that the joints had not been made full, but voids had been left in which ice formed. Frequently the joints were found open to a depth of 2 ft. or more.

The Cement Gun Co. furnished the cement gun at $250 a month; the air compressor at $5 a day; an operator for the gun at $6 a day, and an engineman to run the compressor at $4 a day. The United States furnished 5 to 7 laborers, a horse and cart and an overseer. The lease with the Cement Gun Co. also provided for payment to them of transportation charges on the plant and for 4 days' time allowed for transportation. The transportation charges were $216, being about trebled for the requirement of delivery on the island.

Work was begun at the north end of the extension sea-wall near Castle William on June 1, 1916, and was stopped June 29, 1916, at a point of 4,170 ft. from the beginning. The linear feet of joints pointed was about 22,320, averaging 900 ft. to the working day. At the beginning, the rate was much slower on account of inexperience and bad weather, although the location was near the sand pile and the cement storage. The rate also varied on account of tides, more work being accomplished when low tides occurred near the middle of the day.

In filling the joint, the operator turned on water only until the joint was washed clean, then the mixture of cement and sand with the water, sweeping over any convenient length of 4 to 8 ft. at a time. The mortar filled the joint gradually in from 2 to 5 minutes, depending largely on the voids as well as on the length covered. When the joint was nearly full, the visible completion appeared sudden.

The operator stood on the riprap foundation of the wall during work until the tide rose too high for rubber boots, when a plank swing was hung over the wall for a platform; this was for about 33 per cent of the time.

Some difficulty was met with in the lower joints, which are under water at high tide. They could be filled only at low tide, and the swash of waves or swells from passing steamers would often wash out the mortar for a depth of 3 to 6 in., a result which would happen from any pointing. Covering these joints with a weighted canvas screen was tried, but it was not effectual. Towards the close of the work, a few linear feet of joint were covered with plaster of Paris, ⅛ to ⅛-in. thick. This set at once and stayed on for a day, when the cement had hardened. It was rather slow and expensive for general use.

At the beginning of work, the belt drive from the compressor to the pump wore out and broke frequently. The operator often had to shut off the water, which stopped the pump while the compressor was running. A relief valve in the water line remedied this.

This kind of work unavoidably makes a joint without finish and spatters mortar on the face of the wall. One of the laborers was assigned to smoothing off the joint and cleaning away the surplus mortar before it had set.

It was at first intended to mix the cement and sand at 1 to 2. The Cement Gun men said that their experience led them to believe that the force with which the mortar was driven caused some of the sand to rebound, and that 1 to 3 was a better proportion. This was adopted. In these closed joints, however, the loss of sand from this cause was small. It is estimated that between 10 and 15 per cent of the mortar was wasted from spattering and overfilling the joints, and that this contained practically the same proportion of sand as the original mixture.

To drive the cement and sand through the hose with compressed air, it is essential that the mixture be quite dry. In the early part of June there was much damp, foggy weather and the sand got damp and, although the cement was kept quite dry, the mixture clogged in the hose. It is very probable that the compressed air was also fully saturated. The trouble was overcome by heating the sand on an iron plate over a fire of drift wood.

The filled joints were probed with an iron bar at several points to see whether the mortar penetrated the full depth of the joint. It appeared to do so. A test was made by building a box 3 ft. long (the maximum depth of joint), 18 in. wide and 1 in. high, with one end, 18 in. by 1 in., open. This was laid flat on the wall and mortar driven into it with the gun, as in ordinary work. The box was covered with canvas and sand, and after three days it was opened. The mortar had filled the entire box, with exception of a small pocket of dry sand on each side about half way in, and another very small one at each back corner. The slab of mortar was cracked through in two places, during handling. The bottom of the slab was homogeneous and smooth, with impression of the grain of the wood. The top was uniform only for the outer 12 in.; farther back it had several depressions of ⅛ in. or less, looking as if water had stood there, separating from a too wet mixture, and had dried away. The character of the mortar was not uniform. For 12 in. from the open front it was compact and good; back of this it became more porous with more frequent grains of coarse sand.

A very crude breaking test of sections of the slab was made when it was 16 days old (July 14), by standing in the middle of the sections; the sections were of different widths, according as the slab broke, each being a beam 18 in. long, 12 in. between supports, and 1 in. thick.

	Width on which pressure was applied.	Width of beam.	Approximate breaking load	
			Total.	Per sq. in.
	In.	In.	Lb.	Lb.
Section from inner end of slab...	4	8	100	12½
Section from middle of slab	4	10	150	15
Section from outer end of slab.....	1	12	250	21

This is altogether too inaccurate for a test of the class of mortar; it gives a fair idea of the relative strength in different parts of the slab.

None of the mortar in the slab was really first class; it might be called fair. It filled the joints to an extent which could not be done otherwise:

Expenditures:

Rental of cement gun	$250.00
Rental of compressor	125.00
Services of operator	150.00

Services of compressor engineman	100.00	
Transportation, including 4 days' rental time	216.00	
		$841.00
Rental, 3 tarpaulins to cover cement		41.85
Services:		
Manisees and Ingalls and crew, freighting supplies and general assistance	$171.58	
U. S. inspector and overseer, with 5 to 7 men	641.09	
2 horses, carts, and drivers, 34 days	136.00	
1 double team and driver, 1 day	8.00	
		956.67
Materials:		
800 bags cement	$324.00	
125 28/100 cu. yd. sand	91.71	
635 gallons gasoline	152.40	
Force pump, fittings, and hose for water	81.66	
Lumber, runways and mortar beds	59.76	
Tools: Wheelbarrows, shovels, sand screen, etc.	34.60	
Rope, for moving machines	24.09	
Miscellaneous: Canvas, rubber boots, etc.	39.48	
		807.70
Office expenses and travel	$258.93	
Photographs	7.45	
		266.38
Total		$2,913.60

This cost will be reduced by a rebate on cement bags returned in good condition; not yet determined, but probably about $60.

The value of materials and tools not used up on the work is estimated at $262.70. This will not far exceed the cost of removing them and storing them until needed, and must be regarded as part of the cost of work in a locality such as Governors Island.

The length of joints repointed, 22,320 ft., was measured, and is essentially correct. The open widths varied from 2½ in. to nothing, and the depths repointed from 36 in. to 3 in. These can not be averaged with any accuracy, being almost wholly out of sight. It is roughly estimated that the average thickness of joint is slightly less than 1 in., and the average depth perhaps 12 to 15 in.

The cost of this work with the cement gun was not far from the cost for the same lengths of joint repointed by hand. Hand work would give a better finish, but would hardly extend more than 4 in. into the wall.

The cost at Governors Island is 10 to 15 per cent more than it would be at an accessible point in this city.

In operating the cement gun, a large supply of compressed air is needed. It is used to turn the cement and sand feed as well as to carry the dry mixture. This mixture will choke in the hose unless diluted with a large amount of air. From such observations as could be made, it appeared that the volume of sand and cement carried was from 1 to 2 per cent the volume of the air used as a vehicle.

The amount of water required was given by the Cement Gun Co. as 5 gal. per minute, at pressure of about 45 lb. This quantity was seldom used, and the stated pressure is not needed. The suction from the air blast would draw in the water if delivered at the nozzle under a much lower head.

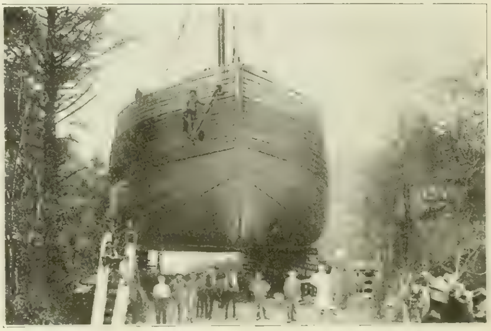
At Governors Island, fresh water could not be had along the line of the sea-wall; and salt water from the bay was used, pumped up through a fine brass mesh.

An examination was made Oct. 9, 1916, and another May 17, 1917. In neither case was there found any deterioration since the repainting was done. For about half the length of wall repointed, the lower joints, at and below half tide, are from 2 to 3 in. slack; and for a length of 125 ft., near the lighthouse, the lower joint is from 10 to 15 in. slack. This 125 ft. was repointed June 22, 1916, when the sea from a strong northwest wind washed the mortar out while it was fresh.

On May 17, test drills were driven 6 in. into the joints at these places; the mortar was everywhere firm and very hard. With hand pointing, the joints would not be filled to a depth of 6 in.

Moving 1,000-Ton Barge 1 Mile Overland

An unusual moving undertaking was carried out recently by a Seattle, Wash., contractor. A 1,000-ton barge, 160 ft. by 40-ft. beam, was moved overland for a distance of one mile. During a heavy gale last March the barge was carried ashore and left on the beach 7 miles below Copalis, Wash. Owing to the surf the barge could not be launched where it lay, so it was necessary to move it across a peninsula to the quiet waters of a bay.



Barge Blocked Up Ready to Cross Swamp.

The barge was raised by means of 200 jackscrews and rollers and blocking placed underneath. It was then moved ahead a few rods and turned around to head for the bay. After leaving the beach for about half the distance sand hills were the only obstacle to be overcome. The balance of the way, however, was covered with timber and swamps, and as it was necessary to keep the track as level as possible much excavation had to be done. In crossing a swamp 300

Nature of Ground Over Which the Barge Was Moved.

ft. wide cribbing 10 ft. high was required to keep the track level.

Power was furnished by a donkey engine aboard a barge, the cables being attached to large logs buried in the sand. About 2,000 ft. of 1½-in. rope and many hundred feet of smaller rope were used for tackle.

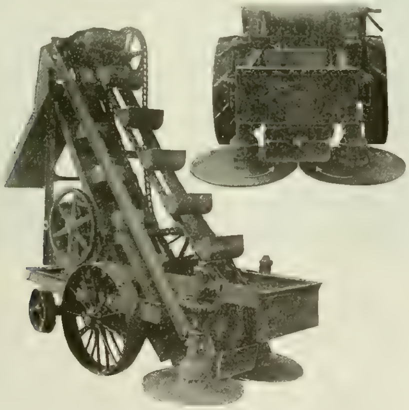
The barge was pulled out as far as possible in the mud flats of the bay and floated at high tide. The whole operation was accomplished in 60 days. Curtis Bros., Seattle, Wash., were the contractors.

Bucket Loader with Disc Feeding Device

A new type of wagon loader is being used with very successful results in the plant of the Wabash Portland Cement Co. at Stroh, Ind. Its distinguishing feature is a digging device which digs to a width of 5 ft. cutting under the pile of material and making a swath in advance of the traction wheels. This mechanism eliminates all labor required in shoveling to the buckets, so that one operator alone can keep the machine continuously up to the capacity.

The digging device consists of a pair of horizontal revolving discs set almost flat on the ground, but with a slight pitch toward the pile. The rotation of the two discs carries the material to the center where it is picked up by the buckets digging from the hard surface of the discs. The wide digging face of this loader enables it to handle a large quantity of material with very little movement of the machine and it also enables the machine to advance into the pile without obstruction.

At the plant of the Wabash Portland Cement Co. the machine is employed in loading cement clinker from piles into small cars. It is stated that the installation of the loader has enabled 3 men to replace a force of 14.



Barber-Greene Wagon Loader.

The loader will handle stone, sand or gravel and, in fact, can be used whenever bulk material of almost any character must be handled in quantities from open piles to wagons, truck or cars.

The loader was developed by the Barber-Greene Co., Aurora, Ill., and patents for it are now pending. It is manufactured by the above mentioned company.

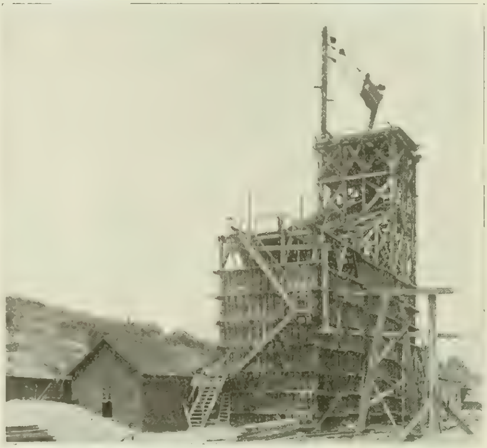
The Great Northern Ry. proposes an expenditure of $20,000,000 for improvements, to include double tracking, and enlarging old shops and building new ones.

Washery Replaces Dry Screening Plant at Tecumseh, Mich.

The present-day demand for sand and gravel is chiefly for thoroughly washed, perfectly graded materials. The effect of this demand is appreciated by comparing plants of recent design with the plants they replaced.

The new washery of the Tecumseh Gravel Co. on the D., T. & I. R. R. 1½ miles south of Tecumseh, Mich., furnishes an extreme example of the contrast between old and new methods.

The old plant of this company produced no washed material. Its principal output was bank run material of which an average of 800 yd. a day was shipped out. A small amount of dry-screened gravel and sand was produced by digging from the bank with a Jeffrey wagon loader, a machine commonly used for loading from stock piles to wagon and trucks. With this machine it was possible to dig from a bank alongside the railroad siding and elevate the material to a revolving screen which rejected the "oversize" and separated the material, producing one size each of unwashed gravel or sand. One kind of material could be loaded at a time. If a car was being loaded with gravel a chute from the screen loaded gravel into the car and the sand dropped to a storage pile to be rehandled later. A Marion "28" steam shovel excavated and loaded the bank-run material direct into gondola cars.



New Plant of Tecumseh Gravel Co.

The new plant shown in the illustration produces three sizes of washed gravel and two grades of sand—concrete sand and plaster sand. A slack line cableway excavator with a 1½-yd. Dull rear-dumping excavator bucket operated by a 12x12 Lidgerwood double-drum, double-cylinder hoist digs the material from the old pit which had been worked to within a few feet of the water-line by the steam shovel. With the cableway it is possible to take out the under-water deposits which tests have shown run to a depth of 70 ft. The operations of this cableway will cover a radius of 500 ft. from the washery.

The cableway excavator digs, elevates and conveys the material to a hopper, which feeds the screens. Then, in turn, the material passes through a Dull preliminary scrubber of 60-in. diameter and 96-in. length and four Dull inclined conical gravel washing screens, each 63-in. x 31½-in. x 84 in. The final step, separating the sand, is accomplished by two 72-in. Dull conical sand separators and a sand launder for the very fine sand.

The "oversize" gravel, rejected by the first screen falls down a chute to a small bin at the front end of the plant to be crushed to 1¼-in. size by a No. 5 Austin gyratory crusher and re-elevated to the screens by a bucket elevator.

A 100-H.P. Primm oil engine furnishes power for the screens, bucket elevator and 5-in. American Well Works centrifugal pump which pumps water to the screens. Rope drive from jack shaft of engine operates screens and elevator and the pump is belt-connected to jack shaft.

The various sizes of material as fast as they are separated find their way into their respective storage bins. Loading for shipment is accomplished by spouts direct from bins to cars. Orders for bank-run gravel are still filled by using the steam shovel and working a new bank adjacent to the washery.

The present output of the washery with six or seven men employed is 500 yd. of all sizes of material in a 10-hour day. The plant has just been equipped with a modern electric spot-lighting system and will be operated day and night.

This plant was designed and equipped by the Raymond W. Dull Co. of Chicago.

Electric Locomotive in Mining Gravel

A 6-ton Goodman electric locomotive operated by trolley, is used by the Wilcox Co. of Chicago, in mining 38 acres of gravel deposits at Fontana, Wis. On a haul of 1,000 ft., 90 tons per hour are handled by this locomotive and four Sackett bottom-dump cars. The locomotive hauls two cars to the plant and back while the other two cars are being loaded by the Bucyrus shovel.

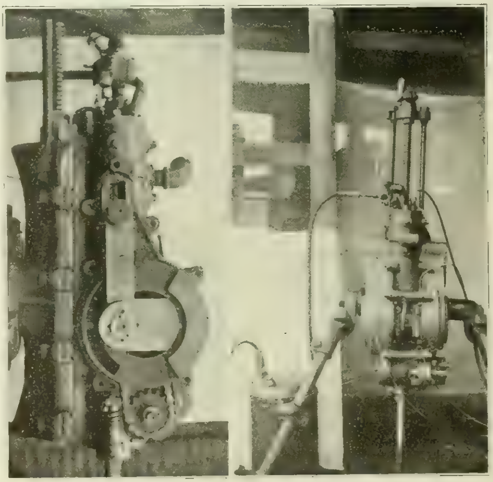
Electric Locomotive at Fontana, Wis., Gravel Plant.

Three contracts aggregating over $555,000 have been awarded in the last few days for state highway construction in Oregon. One of these contracts amounting to over $265,000 calls for the grading and hard surfacing of 15 miles of road.

Self Contained Gasoline Rock Drilling Plant

A gasoline rock drill made as a complete self-contained plant mounted on a tripod has been developed by Mr. L. L. Scott, an engineer of St. Louis, Mo. The drill operates on the hammer principle. A hollow hexagon drill steel is used, no special shank being required, and the water for cooling the engine is run through the hollow steel to the bottom of the drill hole. The engine is a simple single cylinder two cycle. The hammer is moved directly by explosive pressure and strikes a "free piston" blow. There are two pistons, one contained within the other. The outside piston is the hammer and has no mechanical connection with the inside piston, which latter is connected to the crankshaft through connecting rods. An explosion takes place with every down stroke, driving the pistons downward.

The hammer piston strikes its blow on a tappet, which contacts with the end of the drill steel at about 60° before the crankshaft has reached its lower dead center. The inside piston moves on with the crank shaft and uncovers air ports in the hammer piston, and on the back stroke the hammer is picked up on a cushion of air. When the hammer strikes its blow, it is free and disconnected from all parts.



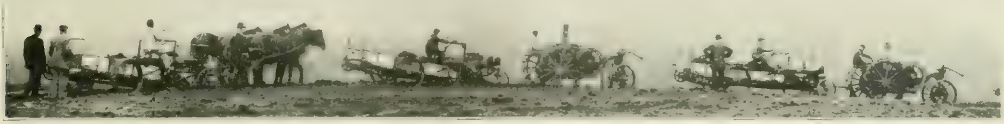
The Scott Gasoline Rock Drill.

The drill steel is rotated step by step by a special "compound" gear. Gasoline is supplied from a small steel pressure tank. A pressure of 2 lb. is pumped up by hand twice per day. The Atwater-Kent Unisparker ignition is used and is entirely enclosed. All oiling is automatic.

These drills have been operated in quarries at St. Louis for the past 5 years. One of them working at the quarry of the Glencoe Lime & Cement Co., St. Louis, is stated to have drilled 68 ft. in hard limestone in a 9-hour day, using 2 gal. of gasoline and ¼ pint of cylinder oil. The machine weighs 200 lb. without the mounting. It is claimed to drill holes up to 12 ft. in depth.

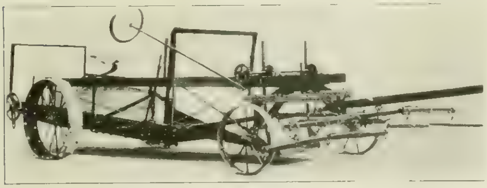
A Self Loading Excavator

A self-loading excavating machine having a number of interesting features has been developed by an Iowa manufacturer. The loading device is attached to the front end of the body, which is pivoted on the rear axle a little back of its center. The cutting blade is attached to the main frame of the body and extends back to a steel guard which extends a little over the lower front end of an endless elevator apron, which elevates the dirt into the front end of the body. In the bottom of the body is a main endless apron, which carries the material to the rear of the body as fast as the front end is filled. The front end of the body, to which the blade is attached, is raised and lowered by a worm gear, which is under the control of the operator and can be held to any depth desired. Both the elevator apron and the main apron are under the control of the operator, and either may be run independent of the other.



Battery of Self-Loading Excavating Machines Showing Methods of Hauling.

In loading the machine the elevator is thrown in gear and the front of the body lowered until the cutting edge is the desired depth, then as the front end of the body is filled the main apron is thrown into gear as desired, until the load is completed. The front is then raised and the load is ready to be delivered. The load may be dumped in one place by a foot lever or spread while the machine is advancing 45 ft. by throwing the main apron into gear. It is not necessary to stop the machine for any operation except when dumping in one place by means of the foot lever.



Self-Loading Excavating Machine.

The machine is hauled by four horses or by a light tractor. In the former case one man handles the machine and the horses. It is claimed that $1\frac{1}{2}$ cu. yd. of earth can be excavated and loaded in about 20 seconds. The excavator is manufactured by the Spaulding Manufacturing Co. of Grinnell, Ia.

Spacing of Drill Holes and Strength of Blasting Charge

In the rock excavation in connection with the widening of the Louisville & Portland Canal at Louisville, Ky., the proper spacing for drill holes was determined largely by trial. At first, holes were drilled at corners of 10-ft. squares, but later the dimensions of the squares was reduced to 7 ft. Even then, some pieces of the disrupted limestone were too large for the shovel dipper, and an additional hole was drilled at the intersection of the diagonals of each square and sometimes several small air-drilled holes were made through the limestone. These small holes were made by small motor-driven compressed air drills. The amount, distribution and strength of the blasting charge was determined by trial. Experiments were made, using dynamite varying in strength from 40 per cent to 75 per cent, and concentrating the dynamite charge near the bottom of the holes, at top and bottom of holes and uniformly distributing the charge throughout the holes. The best results were obtained with the holes spaced 7 ft. in both directions and with a charge of 75 per cent dynamite concentrated in equal amounts near the top and bottom of holes. The drill holes were carried 18 in. below grade, but in spite of this it was occasionally necessary to redrill the bed rock after blasting. With this method of drilling and charging, the amount of dynamite used, per cubic yard of rock, averaged 0.4 lb. The number of holes exploded at one blast was limited to from 10 to 15, because of complaints made by residents adjacent to the work claiming annoyance and damage from flying rock fragments.

New Exhibition to Supersede Annual Cement Show

The first Chicago Cement Machinery and Building Material Show will be held February 6-13 in the Coliseum, Chicago. The Cement Products Exhibition Co. will not stage a cement show in the Coliseum in 1918 and the new show, held under the auspices of the National Exhibition Co., 123 West Madison St., Chicago, is planned to take the place of the annual cement shows.

With few minor exceptions the coming show will be handled in the same manner as the last cement show. The one important change substituted by the new show is that machines and products of interest to builders, even though they do not relate to concrete, will be permitted. Practically the same rules which governed the last cement show will govern the coming exhibition. Vigorous efforts will be made to secure meetings during the period of the show of such organizations as the National Builders' Supply Association, the Illinois Lumber and Builders' Supply Dealers' Association, the American Concrete Pipe Association, the American Concrete Institute, the American Association of Engineers, etc.

The same space arrangement used at the last cement show will be used again. The equipment used at the Coliseum last year has been purchased for the coming show.

L. F. Mead, to whose efforts much of the success of the last several cement shows has been attributed, has been selected to manage the new undertaking.

Names and Locations of New National Army and National Guard Mobilization Camps

The new National Army cantonments and the National Guard mobilization camps, with names of contractors and constructing quartermasters, are located as follows:

NATIONAL ARMY CANTONMENTS.

Seventy-sixth Division.—Camp Devens, Ayer, Mass. Contractor, Fred T. Ley & Co., Springfield, Mass. Constructing quartermaster, Capt. Edward Canfield, Jr.

Seventy-seventh Division.—Camp Upton, Yaphank, L. I. Contractor, Thompson Starrett Co., New York City. Constructing quartermaster, Maj. O'Kelly Myers.

Seventy-eighth Division.—Camp Dix, Wrightstown, N. J. Contractor, Messrs. Irwin & Leighton, Philadelphia, Pa. Constructing quartermaster, Harry O. Williams.

Seventy-ninth Division.—Camp Meade, Annapolis Junction, Md. Contractor, Smith, Hauser & MacIsaac, New York City. Constructing quartermaster, Maj. Ralph F. Proctor.

Eightieth Division.—Camp Lee, Petersburg, Va. Contractor, Rhinehardt & Dennis, Charlottesville, Va. Constructing quartermaster, Capt. Edwards.

Eighty-first Division.—Camp Jackson, Columbia, S. C. Contractor, Hardaway Constructing Co., Columbus, Ga. Constructing quartermaster, Maj. William Couper.

Eighty-second Division.—Camp Gordon, Atlanta, Ga. Contractor, Arthur Tufts Co., Atlanta, Ga. Construction quartermaster, Maj. James N. Pease.

Eighty-third Division.—Camp Sherman, Chillicothe, Ohio. Contractor, The A. Bentley Co., Toledo, Ohio. Constructing quartermaster, Capt. Ward Dabney.

Eighty-fourth Division.—Camp Taylor, Louisville, Ky. Contractor, Mason & Hanger, Richmond, Ky. Constructing quartermaster, Maj. F. E. Lamphere.

Eighty-fifth Division.—Camp Custer, Battle Creek, Mich. Contractor, Porter Bros., Detroit, Mich. Constructing quartermaster, Maj. Earle B. Morden.

Eighty-sixth Division.—Camp Grant, Rockford, Ill. Contractor, Bates Rogers Construction Co., Chicago, Ill. Constructing quartermaster, Maj. D. H. Sawyer.

Eighty-seventh Division.—Camp Pike, Little Rock, Ark. Contractor, James Stewart & Co., New York City. Constructing quartermaster, Maj. John R. Fordyce.

Eighty-eighth Division.—Camp Dodge, Des Moines, Iowa. Contractor, Charles Weitz & Sons, Des Moines, Iowa. Constructing quartermaster, M. A. Butler.

Eighty-ninth Division.—Camp Funston, Fort Riley, Kans. Contractor, George A. Fuller Co., New York City. Constructing quartermaster, Capt. F. J. Herman.

Ninetieth Division.—Camp Travis, Fort Sam Houston, San Antonio, Tex. Contractor, Stone & Webster Co., Boston, Mass.

Ninety-first Division.—Camp Lewis, American Lake, Wash. Contractor, Hurley Mason Co., Tacoma, Wash. Constructing quartermaster, Capt. D. L. Stone.

NATIONAL GUARD MOBILIZATION CAMPS.

Twenty-sixth Division.—Camp Green, Charlotte, N. C. Contractor, Consolidated Engineering Co., Baltimore, Md. Constructing quartermaster, Maj. C. H. Greene.

Twenty-seventh Division.—Camp Wadsworth, Spartansburg, S. C. Contractor, Fiske-Carter Construction Co., Greenville, S. C. Constructing quartermaster, Lieut. Col. J. D. Kilpatrick.

Twenty-eighth Division.—Camp Hancock, Augusta, Ga. Contractor, T. O. Brown Co., Augusta, Ga. Constructing quartermaster, Maj. Gratz B. Strickler.

Twenty-ninth Division.—Camp McClellan, Anniston, Ala. Contractor, John O. Chisolm & Co., New Orleans, La. Constructing quartermaster, Maj. L. C. Dulin.

Thirtieth Division.—Camp Sevier, Greenville, S. C. Contractor, Gallivan Building Co., Greenville, S. C. Constructing quartermaster, Maj. A. G. Doyle.

Thirty-first Division.—Camp Wheeler, Macon, Ga. Contractor, W. Z. Williams, Macon, Ga. Constructing quartermaster, Walter Hernwood.

Thirty-second Division.—Camp MacArthur, Waco, Tex. Contractor, Fred A. Jones Construction Co., Dallas, Tex. Constructing quartermaster, Maj. Matthew Hanson.

Thirty-third Division.—Camp Logan, Houston, Tex. Contractor, American Construction Co., Houston, Tex. Constructing quartermaster, Capt. W. P. Rothrock.

Thirty-fourth Division.—Camp Cody, Deming, N. Mex. Contractor, J. W. Thompson Co., St. Louis, Mo. Constructing quartermaster, Maj. Charles H. Miller.

Thirty-fifth Division.—Camp Doniphan, Fort Sill, Okla. Contractor, Selden Breck Construction Co., St. Louis, Mo. Constructing quartermaster, Maj. George D. Guyer.

Thirty-sixth Division.—Camp Bowie, Fort Worth, Tex. Contractor, J. W. Thompson, Dallas, Tex. Constructing quartermaster, Maj. P. J. Vanzuben.

Thirty-seventh Division.—Camp Sheridan, Montgomery, Ala. Contractor, Algernon Blair, Montgomery, Ala. Constructing quartermaster, Maj. A. W. Reynolds.

Thirty-eighth Division.—Camp Shelby, Hattiesburg, Miss. Contractor, T. S. Moody & Co., Chattanooga, Tenn. Constructing quartermaster, Maj. W. J. Howard.

Thirty-ninth Division.—Camp Beauregard, Alexandria, La. Contractor, Stewart McGehee Construction Co., Little Rock, Ark. Constructing quartermaster, Maj. W. R. Goss.

Fortieth Division.—Camp Kearney, Linda Vista, Cal. Contractor, W. E. Hampton Co., Los Angeles, Cal. Constructing quartermaster, First Lieut. Charles Rogers.

Forty-first Division.—Camp Fremont, Palo Alto, Cal. Contractor, The Lindgren Co., San Francisco, Cal.

Personals

George Wells has been appointed County Engineer of Highways of Pike County, Kentucky, with offices at Pikesville, Ky.

W. L. Sackett has been appointed Superintendent of Waterways of the State Department of Public Works and Buildings of Illinois.

W. C. Hawkins has been appointed Engineer Maintenance of Way of the Coal & Coke Ry., with headquarters at Gassaway, W. Va., succeeding F. D. Cosner, resigned.

C. H. Byers has been appointed District Engineer of the Pacific District, Division of Valuation of the Interstate Commerce Commission, with offices at San Francisco. W. H. Davison has been appointed assistant district engineer.

Lawrence N. Siler, a mechanical and electrical engineer of The J. G. White Management Corporation, New York, N. Y., has been assigned to the engineering staff of the Manila Electric Railroad & Light Company, Manila, P. I., which is being operated by the Management Corporation. Mr. Siler is a graduate of Cornell University.

Leroy K. Sherman has opened offices at 137 South La Salle St., Chicago, where he will engage in a consulting practice, specializing in hydraulic engineering, land drainage, sewage disposal, and public utility organization and appraisal. For the past three years Mr. Sherman has been engineer member of the Illinois State Rivers and Lakes Commission and before that was Assistant Chief Engineer of the Sanitary District of Chicago, having charge of the construction of the controlling works and hydro-electric plant at Lockport, Ill.

News Letters

ST. LOUIS ITEMS.

Smith & Hannan, Commerce Bldg., Kansas City, Mo., and Boatmans Bank Bldg., St. Louis, Mo., have a nice team job to sublet on the Wabash R. R. in Illinois.

Pat Hickey of Hickey Bros. spent several days with his family. Hickey reports their work in the East getting along fine. No shortage of labor over his way.

John Boyle was killed by a train at Grafton, W. Va., on July 17th. Was buried here. His son, Frank, now a sailor on the U. S. Steamer Louisiana, came home to attend the funeral.

The Moreno-Burkham Const. Co. of St. Louis has been awarded the contract for the installation of all sewer and water works in connection with the government cantoment near Battle Creek, Mich. Work will be rushed through so the cantonment may be completed in time for military training work. The Moreno-Burkham Company is one of the largest specialists in sewer and waterworks installation in the Middle West. The company owns and controls fifteen trenching machines suitable for work of this character. E. G. Burkham, a member of the firm, will be in charge of the Battle Creek work. He has departed from Colorado, where he has been passing his vacation, to begin operations in Battle Creek.

Bartson & Millard, Ancell, Mo., want an 8 to 12-team outfit for day work at that point.

Bartholomew Harrington of the Harrington Brothers Const. Co. died in Benton, Ill., on July 30th from the effects of horse medicine he swallowed a few hours before. He complained of feeling ill during the afternoon and started to take castor oil. He poured what he thought was whiskey into a glass. It was horse medicine. The construction camp cook also drank the liquid and was in a serious condition for several hours. Harrington was 40 years old and single. He leaves three brothers, a sister and his mother. At the time of his death Harrington was supervising the installation of a new mine railroad switch at Benton.

Ward Bros. have their outfits grading property work in Cleveland and Akron, Ohio.

J. C. Kaiser, 6407 Bartmer Ave., St. Louis, has a cracker jack 22-team outfit idle.

The Floesch Const. Co., Cape Girardeau, Mo., can use a small team outfit to top off levees where slides have occurred. Will either hire teams by the day or contract on this work. See S. T. Neely, Mgr., of this company at Cape Girardeau.

The L. J. Smith Const. Co., Commerce Bldg., Kansas City, Mo., were awarded some nice steam shovel work by the M. K. & T. R. R. in Kansas and Oklahoma the other day.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, or 503 Delaware St., Kansas City, Mo.

Mulvill Bros. of Alton, Ill., were awarded the contract to construct all of the Alton & Eastern R. R. extension except the C. & A. subway.

P. J. Murphy, Moberly, Mo., has several small pieces of team work on the Wabash R. R. to sublet.

A. B. KOENIG.

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"Engineers Should Oppose Being Controlled by Architects

In our Building and Structural Monthly issue for June we published a letter from Mr. E. T. Thurston, M. Am. Soc. C. E., commenting upon a proposed Architects' License Law for California. We also published an abstract of the bill. In his closing sentence Mr. Thurston said:

> There should be strong opposition among engineers to being licensed or in any way controlled in the practice of their profession by architects, who have yet to show themselves, as a class, noticeably competent in matters of safe construction.

The architects' license law to which Mr. Thurston objects is called "an act providing for public safety in buildings within the state of California," but its title should have been An Act to Provide Work for Architects. Under the customary guise of offering protection to the public, the law, as originally drafted, aimed to compel the employment of architects on every sort of a building, from a cow shed to a sky scraper. Due to the opposition of the San Francisco Association of Members of the American Society of Civil Engineers and of others, the bill finally drawn is a toothless tiger. It roars quite harmlessly. After providing for an examination of applicants for an "architect's" license, it is provided that "structural engineers in independent practice" are exempt from examination. Also "any persons submitting photographs of one or more buildings in California, designed by him, or by persons employed by him" are exempt.

Mr. Thurston states that, in the opinion of San Francisco engineers, a state building code, if properly enforced, would constitute the simplest and most effective means of insuring safe construction. We believe that structural engineers in general will agree with this statement.

"He Picked Those Men Who Were Willing to Study"

A young New Zealander, Robert Laid, in eight years has built up a mail order business totaling $1,250,000 after having started with the proverbial modicum of money and a belief in himself. When recently asked what method he used in selecting department managers he replied: "I promote the men who are willing to study."

Many successful business executives have found that men who are students of business problems are to be preferred to those who rely mainly on their wits. There are no end of things to be learned about the management of the simplest business; yet the average young man who goes into a business enters it with slight intention of studying the literature of the subject. Similarly the young engineer is inclined to try to secure promotion without continuing a systematic study of engineering literature. This is the more remarkable because engineers are generally presumed to have formed studious habits. It seems to indicate that, in spite even of a four-year training in an engineering college, many men graduate with ill-formed habits.

For a score of years we have been accustomed to hear that the main object of an education is to learn how to think. Is it not more important to become habituated to doing things in a systematic way that awakens interest and necessitates thinking?

Courses in Public Speaking for Civil Engineers

If civil engineers are to progress more rapidly in securing administrative political positions, there must be more attention given by them to the art of public speaking. How important it is to reach the public directly and personally if one wishes to secure public support, is well illustrated in the spectacular rise of Kerenski, the premier of Russia. Although the orator type of public executive is likely not to be as prominent in the future as in the past, it is apparent that the ability to address an audience in clear and convincing manner will always remain an asset to any man holding an important public office.

Prof. George F. Blessing, head of the department of engineering at Swarthmore College, several years ago said to the head of the public speaking department of the college:

> I want my men to learn to talk about their business in public. I want them to be able to talk about engineering so that an ordinary audience can understand them and be interested in what they have to say.

Having outlined what it was desired to accomplish, the engineering students were enrolled in a course of public speaking. Beginning with 5-minute talks on engineering topics, the students rapidly developed proficiency and at the end of the year were able to deliver extempore speeches 20 minutes long. Although the speaking at first was confined to technical subjects, it became the practice later on to talk on non-technical matters and even to make short after-dinner speeches.

We commend this practice to all engineering students and members of engineering clubs and societies.

Let the engineer become more vocal in public through practice in platform talks to his fellow engineers.

The editor has learned that if a "skeleton outline" of an address is written on a sheet of paper, and if one rehearsal is held with himself as sole auditor, it is not difficult to find the needed words when the time comes to deliver the address. Two common mistakes are made by those who have had no experience in public speaking. Either the attempt is made to memorize verbatim the substance of an address, or resort is had to the other extreme of trusting entirely to the improvising spirit of the moment. There is a middle course that results in avoidance of the cut-and-dried delivery that characterizes a memorized text and the halting or slipshod utterance so often noticed in the man who has a head full of ideas not pre-arranged for utterance. Marshal your ideas in advance, write down the headings and short reminders; then, with your watch before you, extemporize the form of your address several days in advance of its delivery. If you have time to rehearse it a few times, so much the better. The beginner should avoid departing from the order and substance of the address thus prepared. As one acquires proficiency through practice, the latitude of departure from the original design of the address may become greater. Thus the extempore speaker evolves. But no matter what facility is eventually attained, let it not be supposed the mere shaking of the tongue will cause good fruit to drop from the tree of knowledge unless the tree has been carefully pruned and cultivated.

Uniform Stationery and Drawings

Mr. Emile Low calls our attention to the fact that Governor Whitman of New York has just signed a bill "to make uniform all the stationery to be used by the different State departments." Mr. Low, using this as his text, says:

> Why does it take a sledge hammer to compel officials, and especially civil engineers, to use rational methods?
>
> Every official uses different size letterheads, blank forms, specifications, etc., etc. The Canadian letterhead used to be 15 in. to 18 in. long, something like Chinese scrolls, or more like the "property" stuff you see in melodrama on the stage. For years I have tried hard to get civil engineers to use a standard size, say, 8½ in. x 11 in., cut from 17 in. x 22 in. paper without waste. They continue to use 7¾ in. x 12 in. or 8 in. x 10 in., or some other foolish size to make a lot of waste in the printing offices, to be baled and sold for junk, costing more to bale than what they get for it.
>
> Then there are all kinds and sizes of specifications, especially the abominable one that opens at the end, copied from the lawyers. The engineers have held onto it, but the lawyers have discarded this form long ago.

Precedent, as Mr. Low indicates, holds even educated men in its vise. Go into almost any drafting room and note the use of wide rolls of tracing cloth and blueprint paper. Then ask why drawings are made so large that they must be rolled to be carried or filed conveniently. The answers that one commonly receives indicate that no particular thought has been given to the matter of sizes. Regardless of ultimate use or of the scale of the drawing, huge sheets are still "standard."

Some engineers have ceased the use of large sheets for drawings, except in special cases, and do their drafting on letter size paper. One of these engineers recently showed the editor his files of sketches, maps, bridge designs, etc. With few exceptions every sheet was letter size and punched at the margin so that it could be bound with the text of his reports. Instead of tracing cloth he used cross-ruled, thin paper from which blueprints could be struck off on sheets of the same size. His file cases are of the ordinary kind used for letters, and rolls of drawings are conspicuous by their scarcity.

Standardization of sizes of catalogs, books, letterheads, etc., has long been a favorite theme of the systematizer; and from present outlook writers a generation hence will still be preaching it, while most of us continue our really witless practice of following our personal tastes and habits.

The Proper Use of Man-Power Push Carts

Push carts, or "buggies," have largely displaced wheelbarrows, and would displace them to a greater extent were more thought given to the best methods of handling them. Usually, however, they are operated over a poor roadway that is not rigid enough to begin with and is rendered worse by an accumulation of dirt upon it. The axles of "buggies" are seldom well greased and are never equipped with roller bearings. If used for hauling concrete, no provision is made for the complete, free discharge of the concrete; part of it sticks to the bottom unless the concrete is very sloppy.

The editor recalls previously describing a little stunt used years ago by the Aberthaw Construction Co. in building the Harvard stadium. It consisted in bolting one end of a strip of canvas to the inside of the bucket used in handling concrete. The other three sides of the canvas strip were free, and the canvas rested across the bottom of the bucket, its width being slightly less than the width of the bucket. The concrete rested on the canvas, and, when it was dumped, pulled the canvas along with it. In short, instead of sticking to the bottom of the bucket the concrete stuck to the canvas, but freed itself completely as it slid off into the forms. Then the canvas strip was folded back into its place ready for the next load.

The trackway for push carts should, if possible, be given a down grade for the loaded cart; and it should be made of fairly heavy timbers unless it is well supported at frequent intervals. Then keep it clean and any man will have no trouble in pushing a 500-lb. load.

Because the hauling plant is simple and even crude, do not fall into the bad habit of leaving its managemen entirely to a foreman who may be equally simple and crude.

The Correlation of the Properties of Materials.

If the temperature of a metal is changed, its strength, its elasticity, its electric and heat conductivities are changed. A very small change of temperature may be insufficient to make the changes in these four properties readily measurable; but since there is a gradual change of these properties with greater temperature changes, it is evident that there is an interrelation that is continuous. Generalizing broadly, all the properties of materials are correlated or interdependent. Introduce an energy that affects one of the properties in measurable degree, and you may confidently look for a measurable effect on some other property.

In a paper read at the last annual meeting of the American Society for Testing Materials, Charles W.

Burrows, of the U. S. Bureau of Standards, presented a highly significant summary of tests showing the quantitative relation between the magnetic properties of steel and the mechanical properties, such as elasticity and strength. In determining the strength of a metal by previously known methods, a sample had to be taken and destroyed in the process of testing. But Mr. Burrows is hopeful that by determining a small number of magnetic characteristics, large pieces of steel can be tested without destruction, and their mechanical qualities determined.

Physicists have gradually come to regard every material as being a complex group of energies—an energy-group. The existence of energy does not manifest itself unless a change of energy takes place. But within the confines of every bit of material there is a whirl of moving particles. It is no exaggeration to speak of the cosmos of an atom.

The structural engineer, dealing as he does so largely with energy in equilibrium—with statics—must especially strive to attain the broader and correct conception of matter as dynamic, always dynamic. It will come as a surprise to many of our readers to hear that even when the temperature of a substance is constant, there is a flow of heat from it to surrounding matter. The paradox is explained when it is realized that the quantity of heat that flows out is precisely balanced by the quantity that flows into the substance of constant temperature.

Even gravitation, in the writer's opinion, is always dynamic in its ultimate manifestation. An Egyptian pyramid that has stood "quiescent" four thousand years, has really been as tumultuous within, every second of that time, as the cataracts of Niagara. Bombarded incessantly by ethereal corpuscles, its stones have been pressed toward the center of the earth, and have motionless held their place amid unceasing motion.

Cost of School Buildings at Pittsburgh, Pa.

During the past five years the Board of Public Education of Pittsburgh, Pa., has completed seven new elementary schools and two new high schools at a cost of $3,168,721. The average cost of the general work has been 14.6 ct. per cubic foot. The cost of the heating and ventilating has been 2.9 ct. per cubic foot. The cost of the plumbing has been 1.2 ct. per cubic foot and the cost of the electrical work has been 8 ct. per cubic foot. The total cost of all buildings has been 19.5 ct. per cubic foot. Bids taken last December indicated an increase in the cost of construction amounting to 56 per cent above contracts let a year previous to that date.

Progress on Camp Pike Cantonment.—The buildings at the Camp Pike cantonment, Little Rock, Ark., are now over 45 per cent finished. Stewart & Co., Inc., New York, the contractors in charge of the work, announce that half of the nearly 30,000,000 ft. of lumber required for the buildings is on the grounds and a third of the entire amount is already in place. Hundreds of buildings, including many of the large barracks and the storehouses for quartermasters' supplies are ready for use. Lumber continues to arrive at the rate of a million feet a day and large gangs of men are kept constantly at work unloading the 50 cars of material each 24 hours, a night shift working under searchlights. The sewer and water lines are rapidly progressing, over 1,200 men being employed on this branch of the work alone, and trench-digging and blasting go on all night.

Combined Pressure on Piles from Vertical Loads and Lateral Forces

By N. M. STINEMAN.

Assoc. Mem. Am. Soc. C. E.

It frequently happens that retaining walls, tall chimneys, and other structures acted upon by lateral forces, must be placed upon soft foundations, requiring them to be supported on piles. Most structural designers are conversant with ordinary methods of computing the pressure on the soil under structures of this character, where the soil pressure is a combination of the direct vertical load and the lateral earth or wind pressure. On the other hand, many structural designers are puzzled on encountering a case where the structures must be carried by rows of piles. He realizes that the piles, instead of the soil, must carry the load, and that conditions are different; but he is unable to apply to this case the formulas for ordinary soil pressure, to which he is accustomed.

The formulas derived in this article are intended to provide a quick and easy method for computing the pile loads in any case where a vertical load and a lateral force combine to produce direct compression and a tendency to overturn.

The problem is in reality very simple, for the case is nothing more than that of combined flexure and direct stress on the plane of the base, as AB in Fig. 2. The same principle is involved in the derivation of the well-known formulas for soil pressure under retaining walls. The different method of treatment is due solely to the fact that in ordinary cases the section taking the combined flexure and direct stress is rectangular, whereas in Fig. 2 the section in question is a group of small detached circular sections—that is, the cross-sections of the piles.

As in ordinary cases, the formulas hold good only if the combined influence of flexure and direct stress produces compression on all the piles, since it is impossible for them to take tension.

Notation.—The following notation will be used, in which forces and loads are expressed in lbs., distances in feet, moments in ft.-lbs., and unit pressures in lbs. per sq. ft.:

P = lateral pressure (earth, wind, etc.) along a length of L.
H = horizontal component of P.
v = vertical component of P. If P acts in a horizontal direction, (H = P and v = 0).
W = weight of structure in length L, including earth or other material directly above the footing (in Fig. 2, all material bounded by the figure ACDEFJBA). W is represented graphically as acting at the center of gravity of all vertical loads, exclusive of v.
R = resultant of P and W.
V = vertical component of R, and is equal to W + v. When P acts horizontally, V = W.
e = horizontal distance between centre of base b and centre of gravity of W and v (Fig. 1).
p′ = unit soil pressure from vertical load above on edge of base farther away from V (Fig. 1).
p″ = unit soil pressure on edge of base nearer V (Fig. 1).
b = width of base (See Fig. 1).
L = length of base considered (See Fig. 2).
w_1, w_2 and w_3 = single pile loads due to vertical load V (Fig. 1), in the first, second and third rows of piles, respectively.
s_1, s_2 and s_3 = single pile loads or uplift due to overturning moment Vd (Fig. 2), in first, second and third rows of piles respectively.
p_1, p_2 and p_3 = combined single pile loads due to direct load and overturning moment, in the first, second and third rows, respectively.
b_1, b_2 and b_3 = widths of vertical-load pressure diagram ABKM to be replaced by the first, second and third rows of piles, respectively. (See Fig. 1.)
y_1, y_2 and y_3 = average ordinates in widths b_1, b_2 and b_3, respectively, measured to same scale as p′ and p″.
m_1, m_2 and m_3 = pile spacing in first, second and third rows, respectively. (See Fig. 2.)
n_1, n_2 and n_3 = number of pile spaces in length L, in first, second and third rows, respectively. For each row n is found by dividing L by the corresponding m. Thus, $n_1 = L/m_1$.
a_1, a_2 and a_3 = distance from left edge of base to first, second and third rows of piles, respectively.
[illegible] = distance from left edge of base to center of gravity of piles.

d = horizontal distance from center of gravity of piles to point where R cuts base AB.

k_1, k_2 and k_3 = distances from center of gravity to first, second and third rows of piles, respectively.

I = moment of inertia of pile sections about the center of gravity, or neutral axis. I is expressed in feet to the fourth power.

Vd = overturning moment.

$C = \frac{Vd}{I}$, and is constant for any given structure.

We shall take a retaining wall supported on three rows of piles to illustrate the several steps necessary in the solution of the problem. It is not necessary to include in this article anything on the theory of soil pressure under retaining walls, since every book on masonry or concrete design treats this subject more or less thoroughly and prints the necessary formulas. It is therefore assumed that the designer knows how to design a retaining wall under ordinary conditions, and that he is able to compute the lateral pressure P and the vertical load W, from which he can lay off graphically the resultant R and the vertical component of R, donated by V.

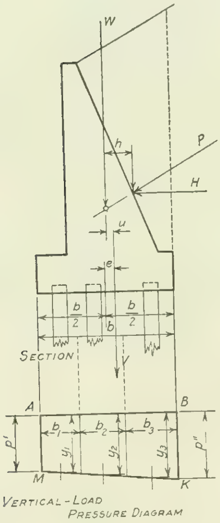


Fig. 1.

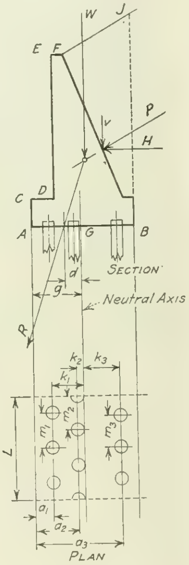


Fig. 2.

The designer should not lose sight of the fact that P and W are in ordinary cases computed for 1 lin. ft. of wall, while in this case the length of wall considered is equal to L, so that the values of P and W as obtained by ordinary formulas must be multiplied by L. Where the problem in hand is a tall chimney, it is best to let P be the total wind force, W the total weight of the structure, and L the entire length of the base.

Direct Load.—The direct load on the piles will now be computed independently of the pressure or uplift due to overturning. As stated before, it is assumed that the designer has computed and laid off to scale the force P and load W.

The following steps must now be taken in succession. (See Fig. 1):

1. At the point where P cuts the back of the wall, lay off to scale its vertical component v.

2. Find the center of gravity of W and v by scaling from W toward v the distance $u = \frac{vh}{W + v}$, where h is the horizontal distance between W and v.

3. Through the center of gravity just found, draw a vertical line. This line represents the line of action of V when H is not acting.

4. Scale the distance e from V to the center of the base b.

5. Find the unit soil pressures p′ and p″, which would occur if the piles were omitted and if the force H were not acting, from the formulas—

$$p' = \frac{V}{bL}\left(1 - 6\frac{e}{b}\right) \dots\dots\dots\dots\dots\dots (1)$$

$$p'' = \frac{V}{bL}\left(1 + 6\frac{e}{b}\right) \dots\dots\dots\dots\dots\dots (2)$$

6. Lay off p′ and p″ to any convenient scale and draw the pressure diagram ABKM. (See Fig. 1.) On this pressure diagram draw vertical lines midway between pile rows. These lines divide the pressure diagram into sections whose widths are b_1, b_2 and b_3, respectively.

7. Scale the average ordinates y_1, y_2 and y_3 (see Fig. 1), and compute the single pile loads in each row by means for the formulas—

$$w_1 = b_1 y_1 m_1, \quad w_2 = b_2 y_2 m_2, \quad w_3 = b_3 y_3 m_3 \dots\dots (3)$$

The foregoing method of finding the pile loads due to vertical load alone, while only approximately correct, is accurate enough for all practical purposes. It may seem at first glance that the same method could be applied to the lateral pressure and vertical load combined, by computing the toe and heel pressure in the ordinary manner and distributing the pressure to the several rows of piles by the graphic method above explained. But this can not be done, since the lateral pressure introduces an overturning moment. On an ordinary foundation the lateral pressure tends to rotate the wall about the toe at A, whereas on a pile foundation the rotation is about the first row of piles. In the latter case the resistance against overturning is considerably less than in the former.

Lateral Force.—The method to be followed in computing the pressure or uplift on piles, due to the overturning moment caused by the lateral force, will now be illustrated by starting with the same conditions as in Fig. 1. It is again assumed that the designer has previously computed P and W, has laid them off to scale and drawn their resultant R. (See Fig. 2.)

The work will be simplified considerably if we assume that the area of a pile head is 1 sq. ft., so that the total area of pile heads composing the section on plane AB is equal to $n_1 + n_2 + n_3$, with the further advantage that the final computed stress, being expressed in pounds per square feet, will be the same as one pile load. Assuming pile heads larger or smaller than 1 sq. ft. would not in any appreciable way alter the final result.

The successive steps to be taken are as follows:

1. Select any reasonable distribution of piles, placing the greater number toward the side receiving the greater pressure.

2. Select any convenient length for L, preferably such that n_1 will be a whole number.

3. Compute n_1, n_2 and n_3 (see notation), and scale the distances a_1, a_2 and a_3. (See Fig. 2.)

4. Find the center of gravity of all the piles from the formula—

$$g = \frac{n_1 a_1 + n_2 a_2 + n_3 a_3}{n_1 + n_2 + n_3} \quad \ldots\ldots (4)$$

5. Denote this center of gravity of the pile sections by the line through G, and scale the distance d. This vertical line through G represents on the plan the neutral axis of the pile sections.

6. Scale the distances k_1, k_2 and k_3, and compute the moment of inertia of the section from the formula—

$$I = n_1 k^2_1 + n_2 k^2_2 + n_3 k^2_3 \quad \ldots\ldots (5)$$

The moment of inertia of the individual pile section about its own axis is very small in comparison with the total and is disregarded in Equation (5).

7. Compute the overturning moment Vd and the constant $C = \frac{Vd}{I}$. From the fundamental relation $s = \frac{Mc}{I}$, where s is the unit stress on a section at the distance c from the neutral axis, M the moment on the section, and I the moment of inertia of the section, the single pile loads in each row may now be obtained by means of the following formulas:

$$s_1 = Ck_1, \quad s_2 = Ck_2, \quad s_3 = Ck_3 \quad \ldots\ldots (6)$$

8. Mark the single pile loads just obtained with a plus sign if the pile is to the left of the neutral axis, and minus if to the right.

Combined Loads.—The combined single pile loads p_1, p_2 and p_3 are now obtained from Equations (3) and (6), by the addition of each positive s to the w having the same subscript, and subtraction of each negative s from the w having the same subscript. If any negative s is numerically greater than the corresponding w, another arrangement of piles must be tried, since there must be compression on all the piles in order to make the solution possible.

Check.—A check on the solution is available from the fact that the sum of the pile loads should be numerically equal to V. Expressed in the form of an equation—

$$p_1 n_1 + p_2 n_2 + p_3 n_3 = V \quad \ldots\ldots (7)$$

This equation must hold true if the solution has been carried out properly, although some discrepancy must be expected because of inaccuracies in scaling.

Factor of Safety.—The factor of safety against overturning may be defined as the moment of resistance against overturning, which is equal to $V(g - a_1)$, divided by the overturning moment, which is equal to Vd. Carrying out the division—

$$\text{Factor of Safety} = \frac{g - a_1}{d}$$

The factor of safety must be greater than unity; otherwise the structure would fall over.

Other General Cases.—The derivation of Equations (1) to (7) has been based on three rows of piles. In cases involving more or less than three rows, the designer may write the necessary equations by adding or deducting the necessary terms in certain ones of the equations given. Thus, with four rows of piles, Equations (3) to (7) must be re-written as follows:

$$w_1 = b_1 y_1 m_1, \; w_2 = b_2 y_2 m_2, \; w_3 = b_3 y_3 m_3, \; w_4 = b_4 y_4 m_4 \quad \ldots\ldots (3')$$

$$g = \frac{n_1 a_1 + n_2 a_2 + n_3 a_3 + n_4 a_4}{n_1 + n_2 + n_3 + n_4} \quad \ldots\ldots (4')$$

$$I = n_1 k^2_1 + n_2 k^2_2 + n_3 k^3_3 + n_4 k^2_4 \quad \ldots\ldots (5')$$

$$s_1 = Ck_1, \quad s_2 = Ck_2, \quad s_3 = Ck_3, \quad s_4 = Ck_4 \quad \ldots\ldots (6')$$

$$p_1 n_1 - p_2 n_2 - p_3 n_3 - p_4 n_4 = V \quad \ldots\ldots (7')$$

Special Case, Structure Symmetrical.—A tall chimney is likely to be subjected to wind pressure in any direction. The base must be designed to resist pressure from any direction, and in consequence it will be symmetrical, with a symmetrical arrangement of piles.

Where this condition exists, it may be assumed that the direct load (with the horizontal force not acting) will rest equally on all piles. Consequently the first part of the above solution, involving Equations (1), (2) and (3), becomes unnecessary. Furthermore, equation (4) is simplified, for the reason that $g = \frac{b}{2}$.

Practical Considerations.—Returning now to the retaining wall in Fig. 1 and 2, the following practical considerations should be kept in mind:

1. All computations may be made with a slide-rule and distances may be scaled.

2. The distance from the edge of the base to the nearest row of piles should be not less than 1 ft. 6 in.

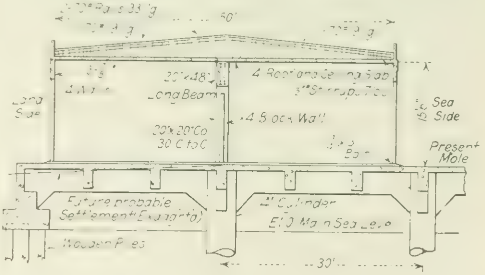
3. Piles should be not less than 2 ft. 6 in. apart, if it is desirable to have rows less than 2 ft. 6 in. apart, stagger the piles.

4. Pile heads should project up into the base at least 6 in., thereby helping to resist lateral movement of the structure.

Building with Suspended Sidewalls

In order to assure the electric charging station at the Cristobal Terminal of the Panama Canal against settlement, it was constructed with a continuous reinforced concrete beam which extends the length of the building on the center columns and from which the sidewalls are literally suspended by means of cantilever beams set at intervals of 10 ft. The walls are only 4 in. thick. The wall on the sea side is made fast to the paving by means of anchor bolts.

The building is at the head of the slip between Piers 8 and 9, on the concrete paving on the mole back of the landing wharf for small boats. The weight of the building is carried on a row of columns extending along the longitudinal axis, and these columns are supported on the steel and concrete caissons on which rests the paving at the head of the slip. On the side next the land the paving is supported on timber piles which have settled slightly.



Cross Section of Electric Charging Station, Cristobal.

The building is 271⅔ ft. long by 51⅓ ft. wide, 1 story high, and will be used for the repair shop and electric charging station for the electric trucks employed at the docks at Cristobal. Pending the arrival and installation of the electrical equipment it has been placed in service temporarily as a loft and storage house. A cross section of the station, reproduced from the Panama Canal Record, from which this note is taken, is shown above.

Selling the Services of a Construction Company

At the World's Salesmanship Congress last June at Detroit, Mich., three papers of particular interest to building contractors were presented. These papers outlined the methods employed by large construction companies in selling their services for private work. Incidentally the authors—Mr. Leonard C. Watson, president the Aberthaw Construction Co., Boston; William P. Anderson, president the Ferro Concrete Construction Co., Cincinnati, and J. P. H. Perry, contract manager Turner Contracts. Extracts from the papers follow:

LEONARD C. WASON.

Contracts on some privately owned work are let on cost plus fixed sum or percentage profit basis, and for these aggressive selling is needed. I am pleased to say that these types of contracts are growing in popularity. Some of the arguments which the salesman can use to persuade a buyer to accept them are:

The work can be started before the plans are made and six weeks' time can be saved.

The contractor's and the owner's interests are mutual. Therefore, better and cheaper results are obtained than with a lump sum contract where the parties' interests are antagonistic.

Changes, either additions or deductions, can easily be made at cost.

The mutuality affects the design, purchasing of material, and sub-contracts, obtaining of labor and finance; eliminates frictions with the inspector.

The first step necessary is to seek out opportunities for obtaining these types of contracts. The most effective method is to visit cities and towns seeking information from all available sources, including calling on the various parties who are thought to be considering the erection of new buildings. This method is slow and expensive. One man cannot cover much territory and do it well. This scouting, however, does not take the best men, and only infrequently brings the scout in touch with the high executive of the company who has the final say in awarding a contract. It should be so well done, however, that it leaves a lasting favorable impression on every one seen, as thereby subsequent work is made much easier. The creation and maintenance of a wide acquaintance and keeping in touch with those who have been met are a valuable asset leading to new business, though they may not bring immediate results. The construction information agencies and the news items in the technical press are too late to be useful, as information is not made public until the party is ready to receive bids.

A less expensive way to cover a large field is by advertising literature. The construction company seeking day work or fixed sum profit contracts needs to reach directly the executive official in whose hands rests the final decision as to awarding a contract. As these men change from time to time, it is necessary to keep in touch with one or two others who may be promoted. It is also necessary to be on good terms with the engineer in the employ of the executive in order to be able to execute a contract to the best interests of all concerned. The engineer, however, very seldom has much influence in regard to awarding contracts, although if he is hostile it may either make it impossible to obtain the contract or make the latter undesirable if obtained. Therefore, the style of advertising must be adapted to these needs.

Experience has shown that the most effective though perhaps more expensive way is by compiling carefully a mailing list of the executives and directors of companies whom it is desired to interest; of large investors and some of the engineering and architectural profession. It can be taken for granted that little if any of the advertising literature will be kept or referred to later. It must, therefore, be so designed as to tell its story and make an impression that will last until further matter has been received.

The writer's company has, after various experiments, decided on the plan of sending something once a month to its mailing list. This necessitates something bright, interesting and brief, and therefore not very expensive in itself. If the advertising makes enough impression on the recipient to draw an inquiry it has done its work. These are very desirable, as they bring the salesman and buyer together on a very pleasant basis, greatly increasing the former's effectiveness. Then the real selling campaign begins.

No fixed rules can be laid down of methods to be followed. The principle underlying all methods is to win the confidence and good will of the prospective client by direct personal contact and by this means obtain his order. Confidence in the salesman's sincerity and knowledge is absolutely necessary. He is presumed to be the mirror that reflects the company. Assumed that he is a total stranger at the start. Write a letter for an appointment; send some information and perhaps literature to make the prospect want more more and be willing to see you. Then get a letter of introduction from a mutual friend. This will get you past the office boy. The representative who calls must be of pleasing personality, with ability to meet the prospect on his own footing and to make a good impression. He should be able to answer almost any question asked him regarding the operating details of his own company intelligently and authoritatively. He must be perfectly frank and truthful, even if it results in losing an order. A favorable impression is left that some time will help the salesman's company. Many salesmen fall down by their failure to tell the truth when it hurts.

He must everlastingly present the main issues, being careful not to talk of details which will only weary the buyer, and certainly will not tend to obtain his signature. The decision must be hammered through on principles.

It is desirable that he should know enough about other lines of work so that he can, without being officious, offer advice wisely on matters concerning the business of the prospective client. If he is able to do this latter he is sure to make a real impression. This requires a salesman of unusual ability and experience.

After making a man's acquaintance the steps which follow are easier to determine upon. They consist in part of getting his friends to write or see him in your behalf. He is affected most by successful competitors in his own line of business who write or see him and endorse your company. Induce him to write to ten or more of your recent clients so as to get disinterested opinion from those who have had recent experience with you as to your worthiness. If they come from men respected in the business world they will frequently land the job. This implies that your company is absolutely reliable, honest, trustworthy and frank in all its dealings, as well as thoroughly competent. Otherwise you would be taking grave chances to entrust your reputation to past clients who know you so well by recent intimate experience.

This leads again to the question, what has a construction company to sell under the cost plus fixed sum type of contract? Its service—that is, its ability to construct a given piece of work quickly, economically and safely, to the complete satisfaction of the owner and his engineer, so that he will be satisfied or more than satisfied with the final result, and can be relied upon as a salesman to help you sell subsequent work on account of his enthusiastic endorsement of the service he has received. It is certain that a company doing this type of business must give better service than the ordinary run of contractors in order to make it worth the owner's while to employ the company to do its work rather than another contractor as the result of competitive bids. The construction company must, therefore, have a most efficient organization to back up its selling force.

It has been found desirable and almost necessary for the salesman to keep in touch with the owner and the contract from start to finish in order to see that every detail of the agreement with the owner, both written and verbal, is lived up to—not only in letter, but in spirit; and, if possible, that results may be even better than those promised when the job was sold.

The salesman must be somewhat of a free lance, particularly in regard to his time, so that he can keep an appointment at the purchaser's convenience without fail. It requires a much different temperament for a man whose time is largely devoted to selling and not fully occupied, from the man who executes the work and must be always available to supervise details of construction, and who is largely absorbed in numerous details which do not give him time for reflection and decision on the larger problems which come before the salesman. Therefore, the two activities cannot be combined in one man.

J. H. P. PERRY.

Selling a concrete building to its owner usually really means the getting of the contract to erect such a building. It seems to me that fundamentally it makes little difference whether we are out to get a lump sum contract, a cost plus percentage contract, or a cost and profit-sharing contract, or any of the many service forms of building contracts—the underlying problem is to get the job. The perfect salesman for this class of business is the fellow who can get the contract.

It has been my experience that contractors weaken their selling campaigns the moment they attempt to dictate to the prospective customer how that customer shall do his business. Our position has always been that we were out to sell our services to our customers on any fair basis and that the form of contract they chose was of secondary importance.

Suppose you hear of a factory that is going to be built and you decide you want the contract.

You've got considerable of a task to make the proper approach and interest your prospect in your proposition. Perhaps you have, first of all, to sell concrete as compared to steel or mill construction if the status of the building, so far as materials or construction is concerned, is not already established. That accomplished, either by you or previously, next comes the presentation of the actual contract-getting talking points, such as your company's record of work done, its present readiness to erect the building in question, its financial strength and the perfection of its organization. Then the merits have to be made clear of such factors as the plant ready to send to the job at once, the liveness of the traffic department, the speed records, and what certainty of delivery means, and, above all else, dependability of performance.

To drive home to the buyer's inner consciousness, to that part of him which actually moves himself as distinct from the external casual momentary side of him, these selling arguments, and also to make each of the many other talking points count and win; to tell this story so that the listener will believe it, and, what is more, believe it so he knows unalterably that what is back of the salesman is the best on the market —all this is ordinarily as much as the salesman can hope to accomplish.

If you bring up the question of the particular form of contract that the contractor will alone accept you add to the salesman's task and bring in a new element which really is a subject by itself and but a detail of the big selling problem.

The statement has been made that no selling is possible except when the contract takes the form of a service or percentage document. I want to take exception to this statement. I know of many instances where hard, intensive selling—such, for example, as interviews, telephone calls, frequent telegrams, photographs, monthly, weekly, daily, twice a day, influence channels properly worked, printed literature, inspection trips to similar jobs—where such good, hard sweating has landed the contract at a preference in the straightest and hardest kind of competition.

The intelligent owner starts out not to buy a particular kind of contract, but to select the contractor he believes will serve him best. Of course if the contractor can persuade the owner to award the job without competition, so much the better; and for this kind of a deal the service of percentage contract has many merits and advantages and is rapidly coming into force. In fact the writer's company out of 32 concrete buildings contracted for in the first five months of 1917 handled 26 on a cost and percentage basis. But as far as the general selling problem is concerned the form of contract is secondary. Sell your services first and then sit down with the lawyers to sign the papers. The contract form is but one of the good building salesman's many talking points—to be used as needed.

Industrial executives in letting building contracts may, in my experience, be divided into two broad classes, and I believe this division applies pretty widely to any set of buyers:

First, the man (or company) who wants what he wants more than the money it costs.

Second, the fellow who thinks more about the price than he does about his purchase.

Number 1 you can sell. He wants a good building, built on time, and is willing to pay a fair price. Secure his confidence and let him write his own contract (whether he takes competition or not depends on the salesman or on unchangeable conditions). There is, as other builders have well pointed out, no better line of attack than to reach your man through his own industry or his own friends. Another good way to sell buildings is to let some one else sell for you. Impartial opinion, real or ostensible, goes miles beyond prejudiced salesman's talk. Architects or engineers should be cultivated to this end.

Often competitive bids are taken by this first class of buyers, but they select from their bids the concern they believe to be the best. Of course, price has to be considered, but is of secondary importance. A good building salesman keeps it there. The refusal of a job at a price other than your bid is a situation to be sought and of great value when secured.

Number 2 can also be sold, but it is a far harder accomplishment and rather rare, unless we consider getting a job on price selling. Personally I think it is order taking. Price alone is being more and more talked out of the modern contracting business, but it's a mighty big factor yet.

The architect and the engineer are susceptible to the same line of thought as the owner. Of course the details of approach, argument and closing are radically different, but the foregoing principles are fundamentally correct here as well.

In selling reinforced concrete buildings a man is arguing the merits of a material or of a class of construction.

In getting a job the contractor is, of course, selling services. Often the two problems dovetail. It seems to me, however, that for either or both the following requirements are vital to successful selling.

First: Perfect your organization to the point where it can and does do what is claimed for it. Overstatements of merit gives but temporary success.

Second: Advertise energetically and as extensively as your purse affords. Job signs, booklets, photographs, magazines, newspapers—all are effective.

Third: Intensively sell by means of men of pleasant personality who know their game—that is, are experienced in the concrete construction field, can design broadly and advise knowingly, and, above all, who have energy and courage and won't take no.

W. P. ANDERSON.

From the experience of our company I feel that salesmanship plays an important part in obtaining work even on a competitive basis. This scarcely applies to competitive work let by public bodies, but even they have some discretionary power, and it is advisable to have those who control the letting of such work familiar with the reputation of the bidder. In bidding on private competitive work the owner is not bound by any rules and often favors a contractor on account of his reputation for fair dealing and excellent work.

There are certain general points to be considered in the selling problem regardless of the form of contract, and other points must be considered with particular reference to the class of contract under which the salesman is endeavoring to get the work. The overhead expense of a construction company is a small percentage of its total business. It can be made lower on work done on a cost plus a fixed sum or percentage than for work done on a flat price, as in the latter case many more careful and expensive estimates of cost are required in getting work. The money saved can be utilized in giving more to actual clients, by being liberal in settling disputed points, thus causing them to become repeaters and boosters, which is one of the greatest selling assets. The tendency in competitive bidding to estimate a great number of jobs is partially due to the fact that architects expect it. Sometimes the contractor guesses or obtains a figure from other contractors in order to put in a high bid to satisfy the architect. High bidding does not hurt the competitive bidder as it creates a feeling of superiority, and, other things being equal, the superior firm gets the job, often at a higher price than his competitor. This may have a different effect on clients letting work on a cost plus a fixed sum or percentage basis, as here he is vitally interested in the contractor's ability to do good work at a minimum cost and maximum speed, with as little annoyance and friction as possible. Our salesmen emphasize these points as well as our firm's engineering ability, which often causes a great saving in original cost or in the operating cost when the building is in use, and we bring these facts home by having former clients write or speak of them to prospective clients.

There is a tendency for architects and owners rather to look down upon the contractor, hardly considering him their equal, but as a slick fellow who will bear close watching. They consider it a favor on their part to allow the contractor to bid, not realizing the expense he is put to in so doing, and that they are the ones that need the favor and that in reality the shoe is on the other foot. The salesman should be independent and not tolerate this attitude, but consider himself absolutely on an equal plane. The class of men in control of the firms who are forging ahead in the field of getting work on a cost plus a fixed sum or percentage basis are of the highest type, and the reputation for honesty and merit required for this class of work does not go with servility.

Over 90 per cent of our present work was obtained on a cost plus a fixed sum or percentage basis, which is growing in popularity due to the many advantages inherent in this form of contract. The munitions board, Council of National Defense, is thus letting contracts, due to the speed obtained thereby. The salesman must overcome a prejudice against this form of contract, as at first an owner cannot see the merits, often because he does not get work this way, not realizing the difficulty of checking costs in a factory, with large overhead expense and more than one client, is overcome where practically the entire work is done at one spot and for the client exclusivly. The feeling that the contractor is a robber and holdup must be overcome, but this feeling in general may be made an asset to the salesman where he can show that his firm does not possess these qualities and can convince the owner of the manifold advantages of the cost plus a fixed sum or percentage contract.

It requires an exceptionally high type of man to go after this class of business. He should have a pleasing personality, be a good mixer, and have confidence obtained by previous experience, in convincing clients of the advantages of the form of contract recommended and the exceptional service his particular firm can render. Often a complete knowledge of design and ability to estimate cost is necessary where the prospect is uncertain as to his exact needs and wishes suggestions or to know at once the costs of various types of building. In most cases, however, the salesman need not be an engineer, and should have no other duties which might interfere with his work.

To insure good workmanship, speed and satisfied clients each job needs a group of men thoroughly tried out in the company's own organization, and consequently the unit of sale is large and may average considerably over $100,000 for those jobs which are not near enough together to be handled by one organization. Consequently, although the percentage cost may be small, a large sum can be spent in landing a single job.

We find it better to confine our intensive salesmanship work to a limited number of very good prospects instead of trying to go after all the prospects we hear of. When a prospect looks good, however, stick to it until the job is landed or lost.

In short the secret of successful selling of a construction company's service is to first build up an efficient organization; obtain a high reputation for honesty, engineering ability, fair dealing, speed and good work, and then convince prospective clients of these facts and the advantages of having this kind of a contractor do his work.

Conveying Building Materials by Gravity Rollers

A recent development in the building construction field is the employment of gravity roller conveyors for transporting materials, thus doing away in a measure with hod carriers and wheelers. This method of handling cement, tile, brick, mortar and even form lumber has been used in connection with the erection of many of the largest reinforced concrete buildings built in the last few months.

The conveyors consist of ball bearing rollers assembled in a steel frame. They are made in sections and provided with couplings which permit a line of any desired length to be assembled quickly. The conveyor line is supported on horses or on adjustable jacks, one at each coupling, and is given a slight incline. Ordinarily a fall of 5 per cent is sufficient to move any kind of building material. The portable units of the Mathews' standard conveyor are 4 ft. and 8 ft. in length for the straight sections. The curve sections are made in 90° and 45° angles. The conveyor designed mainly for handling brick is made in widths from 8 in. to 10 in. and ranges in weight from 18 lb. to 24 lb. per lineal foot. Conveyors for other classes of materials are made in various widths from 12 in. up to 18 in., and with rollers spaced from 3-in. centers up to 18-in. centers. A 12-in. carrier with rollers spaced 3 in. from center to center weighs 21 lb. per lineal foot. The same carrier 18 in. wide runs to 26 lb. per lineal foot.

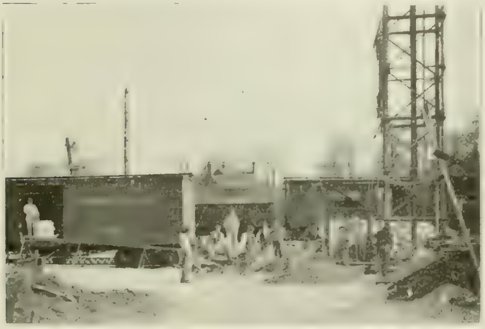


Fig. 1—Unloading Cement with Gravity Roller Conveyor.

Among the larger contractors using the Mathews conveyor are the Ferro Concrete Construction Co. of Cincinnati, O., and the Aberthaw Construction Co. of Boston, Mass. The latter company carries the conveyor as a part of its standard equipment and a specified length is shipped with the other equipment to every construction job of any size. The accompanying illustrations show various ways in which these carriers are utilized by the Aberthaw Co., while the results make clear the economy. The possession of such equipment leads to considerable ingenuity in its use.

In Fig. 1 is shown a short length of a conveyor unloading cement at the Stanley Works job in New Britain, Conn. This was in the early stages of the work, only two or three cars being unloaded in this way, and cement being conveyed only about 20 ft. The brick on this job was also unloaded by means of a carrier, and lumber was conveyed from stock piles to the saw bench. Considerable saving was effected by moving the lumber in this way, although no figures can be given. In this connection, it is interesting to note that the finished building of the Stanley Co. is equipped with a Mathews gravity circular conveyor which runs from the 8th floor down to the 2d floor, making four complete turns in seven stories, with 6-ft. 3-in. radius and 3-ft. 8-in. clear opening in the center. The conveyor handles the goods as packed on all floors, and delivers them to the second floor, whence they are placed either in storage piles or in freight cars.

In connection with the construction of the large building for Colt's Patent Fire Arms Mfg. Co., at Hartford, Conn., one of these carriers effected very great economy in unloading cement. The building ran at right angles to the track where the cement cars were set, and the cement shed was placed in the angle formed by the building and the tracks about 30 ft. away from the building, and perhaps half that distance from the track. Several cars were placed on the siding at one time in some instances, and it was not always possible to have the cement cars at the point nearest the cement shed. The carrier was, therefore, set up in some instances a distance of as much as 300 ft. on either side of the cement shed. Cement was placed four bags on a wooden pallet, and the pallet placed on a carrier which conveyed it parallel to the track until opposite the cement shed when it turned a right angle and ran into the shed where the cement was removed and piled. This shed carried the storage for the job, which consisted of about 30 per cent of the net requirements or barrels. The balance of the cement was unloaded from the cars to the mixers which were about half way down the building, where there was not sufficient grade to use the gravity carrier. The railroad tracks were elevated probably 12 ft. above the level of the cement shed floor.

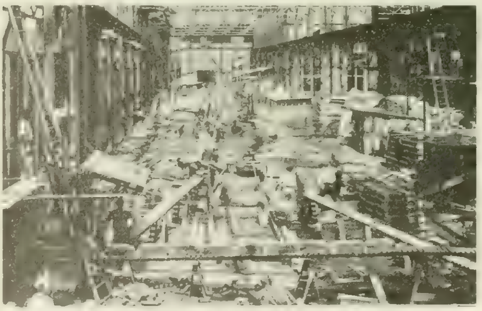


Fig. 2—Gravity Roller Conveyors in Construction of Plant of Farrell Foundry & Machine Co., Ansonia, Conn.

Another instance in which this conveyor was used by the Aberthaw Co. was one some recent work for the Fore River Shipbuilding Corporation at Quincy, Mass. It was found necessary to move a pile of creosoted railroad ties numbering about 1,200 to a point about 75 ft. distant. A line of gravity carrier was set and the ties placed on it one at a time lengthwise and transported without difficulty. The ties were loaded by two men and unloaded and piled by four men at an estimated cost of about half of the expenditure that would be necessary if they had been handled a similar distance by hand.

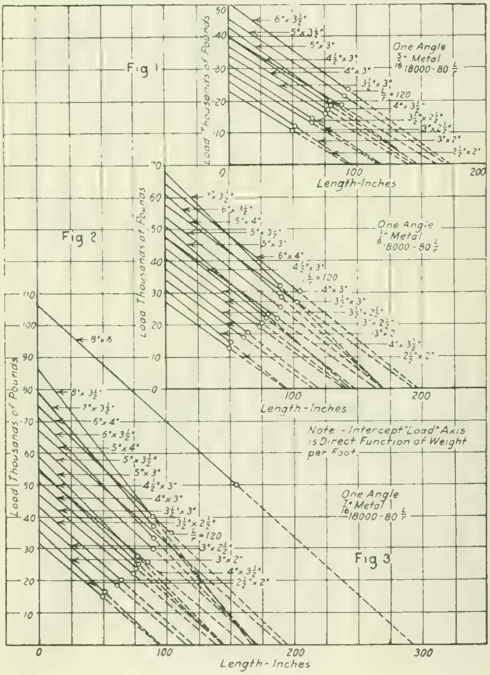
Curves for Angles as Compression Members

By E. DOW GILMAN.

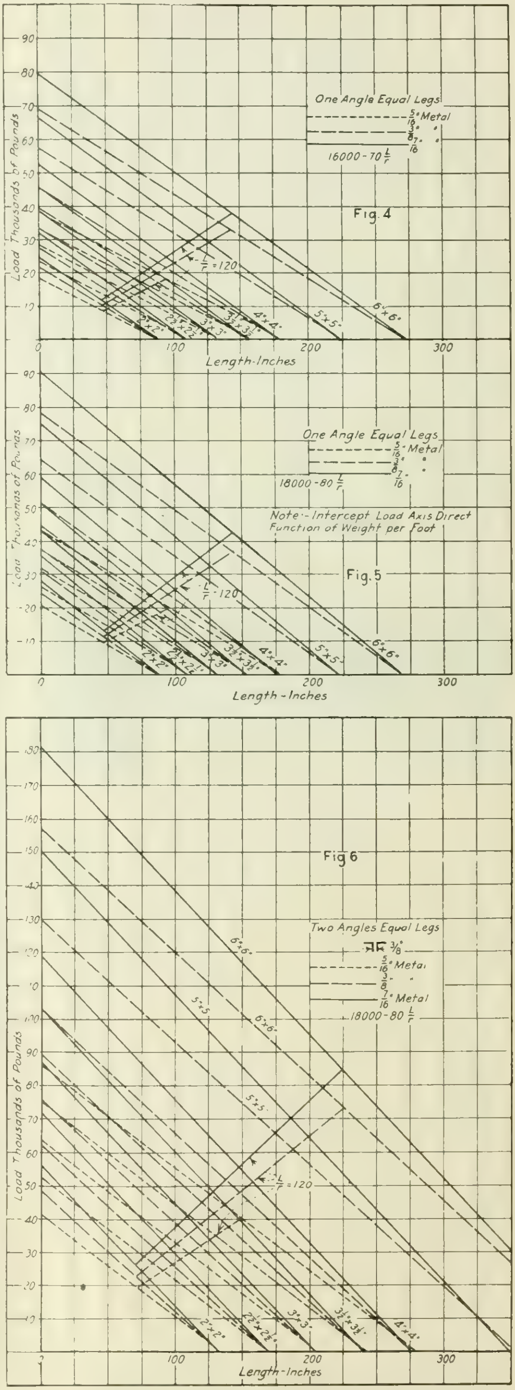
Instructor Experimental Engineering, University of Minnesota.

In the design of steel compression members two factors are generally known: the length of the member and the total load that it is to support. With these known it is necessary to determine what section or combination of sections is most economical and will support the load within the limits of safety as expressed by one or more of the many known column formulas. In all of these formulas the slenderness ratio, the ratio of the length to the least radius of gyration of the section chosen, is the determining factor upon which the allowable load per unit area depends, and the area must be such that this allowable unit load will not be exceeded when the total load is sustained. The most common formula for determining the allowable unit load is S = 16,000 — 70 L/r, where S is the load in pounds per square inch, L is the length in inches, and r is the least radius of gyration in inches. The curves here presented were plotted for use in work where the allowable unit load was found by the formula S = 18,000 — 80 L/r, a formula similar to the one above, but giving slightly higher unit loads.

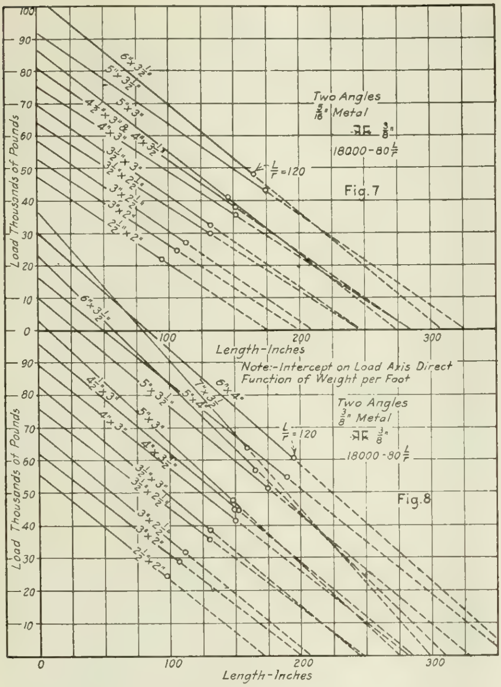
When choosing a section of a given length to support a given total load there are two methods generally employed. The steel handbooks contain tables showing the necessary elements of the common sections used. A section may be chosen for investigation, the

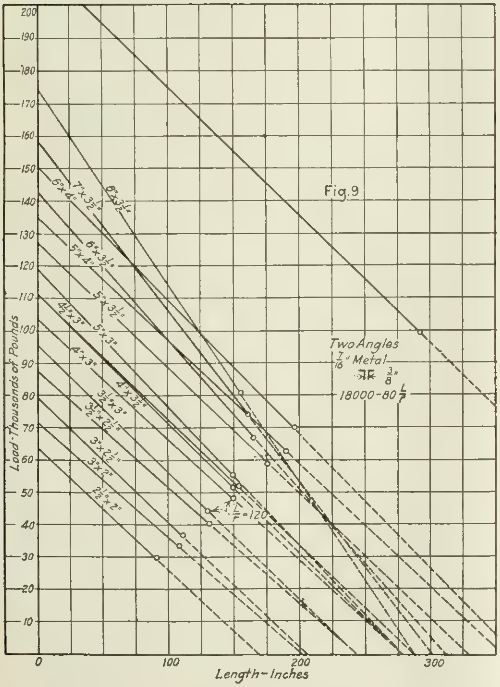


Curves 1, 2 and 3, One Angle, 5/16-In., ⅜-In. and 7/16-In. Metal.



Curves 4, 5 and 6. One Angle, Equal Legs, and Two Angles, Equal Legs.





Curves 7, 8 and 9, Two Angles, 5/16-In., ⅜-In. and 7/16-In. Metal.

allowable unit compression determined by formula, and if the given total load divided by the area of the section does not exceed this allowable stress the section is taken as strong enough to support the load, provided also that the slenderness ratio does not exceed a specified maximum, another factor requiring investigation. In most cases the economical section will be the one in which the metal is so placed as to give the greatest allowable unit stress and the least area to carry the load within this limit of unit stress. To obtain this may require investigation of several sections.

A second and more rapid method of choosing a section to carry a given load is to refer to table of safe loads for specified sections of a given length contained in many handbooks. To present these facts in a graphical manner, a method which greatly facilitates and aids one's judgment, the accompanying curves were plotted and have been used by the writer with splendid success.

These curves have been plotted for only those particular sections for which the writer was having most frequent use. They may be readily extended to include other sections. The curves here presented are for 5/16-in., ⅜-in. and 7/16-in. angles, using as a strut one angle, equal and unequal legs, and two angles, equal and unequal legs, the long legs back to back and ⅜ in. apart. The allowable unit stress is expressed by the formula $S = 18{,}000 - 80\ L/r$. The abscissae represent the length of the member in inches, and the ordinates the total load in thousands of pounds that the member of given length will carry, with the unit stress as expressed in the above formula. The total allowable load varies in direct inverse ratio with the length, and the straight line representing this variation may be easily plotted from the extreme conditions. When the allowable load (the ordinate) equals zero the length is a maximum and is equal to $L = 18{,}000\ r/80$, and when the length (the abscissa) equals zero the allowable load is a maximum and is equal to 18,000 times the area. The straight line between these points represents the maximum loads for corresponding lengths. Furthermore, the lighter of two possible sections may be chosen at a glance. The intercept on the load axis, being directly proportional to the area, is also directly proportional to the weight per foot. That section represented by the line which fulfills the required conditions and intercepts the load axis at the lowest point is the lighter. For example, if a member 100 in. long is to support 50,000 lb. we find from curve 9 that two 3½ x 2½ x 7/16-in. angles will support 51,800 lb., and on curve No. 7 that two 4½ x 3 x 5/16-in. or two 4 x 3½ x 5/16-in. angles will support 52,500 lb. The intercept of the first on the load axis is 87 + and of the second is 81 —, so the second or the 5/16-in. metal will be the lighter, even though the maximum load that it can carry is the larger. This fact becomes known relatively without the necessity of knowing the exact weight which would show that two 3½x2½x7/16-in. angles weigh 16.6 lb. per foot and the two 4½x3x5/16-in. angles weigh 15.4 lb. per foot.

The length at which L/r is equal to 120 is shown on the curves, and the length for any other desired slenderness ratio could be plotted in a similar manner. The curves assume equal distribution of stress over the entire area, an assumption commonly made, though evidently an error.

Relative Effectiveness of Various Types of Roofs in Preventing Condensation

Laboratory tests have been conducted by F. P. Sheldon & Son, engineers and architects, Providence, R. I., to determine the relative effectiveness of various types of roofs in preventing the formation of condensation upon their under surface. The results of these tests were outlined in a paper presented by the above mentioned firm at the last annual meeting of the National Association of Cotton Manufacturers, from which the matter following has been taken:

Each sample roof was tested under three different conditions of heat head to obtain results corresponding to outside temperatures of about 20° F., 0° F. and minus 20° F., for a given inside temperature of 70° F. in each case. All tests were started only after readings of the various thermometers indicated that the thermal conditions had become constant. Steam was then very slowly admitted to the test box, resulting in an increase of relative humidity as noted by rise in the wet bulb. Compensation for heat added by admission of steam was made by adjusting the amount supplied through an electric heater so that the dry bulb temperature during the test remained practically constant. Formation of condensation on the underside of roof was noted, this occurring, of course, when the dew point of the air within increased, and became equal to or higher than the temperature of the surface in question.

The tests embraced concrete and plank roofs with various types of insulation. A curve was plotted on the three points obtained, relative humidities being used as abscissae, and heat head or temperature difference as ordinates. The diagram shows the curves obtained for various sample roofs, and since they are based on 70° F. dry bulb temperature the corresponding outside temperature as well as heat heads are also shown as ordinates.

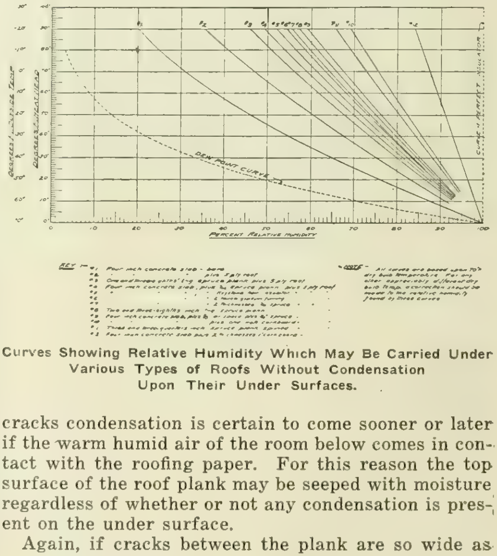
In the diagram all curves are prolonged through a common origin, which is a theoretical point based on 0° heat head; that is, if the temperature of the air on both sides of a roof of any material is the same, condensation will not occur until 100 per cent relative humidity is reached.

Starting from this point two interesting theoretical curves may be drawn, as indicated by dotted lines. They constitute the limiting curves between which all materials whatsoever, from the most perfect conductor of heat to the most perfect insulator, must fall. The first, which is a vertical at the extreme right, is the line of the perfect insulator. It is purely theoretical and illustrates that if it were possible to obtain such an insulator 100 per cent relative humidity could be carried at any difference in temperature between the outer and inner surfaces, because there would be no flow of heat, and consequently no temperature gradient within the material. That is, the surface temperatures would be exactly the same as the air with which they are in contact.

The second curve at the extreme left is designated the "dew point curve," and represents the depression of the dew point (based on dry bulb temperature of 70° F.) for various relative humidities from 3 per cent to 100 per cent. This curve is also purely theoretical and illustrates that the poorest insulator will carry somewhat greater relative humidities than those indicated.

It should be noted that all these curves have reference to the particular relative humidity at which condensation will take place on the underside of roofs. With regard to wood roofs, however, there is another important consideration which must be taken into account; namely, the cracks between the plank afford a more or less direct channel by which the warm, moist air in the room below may reach the underside of the roofing paper. Since the standard 5 or 6-ply tar and gravel roof is a poor insulator of heat, the temperature of its under surface is consequently but slightly warmer than that of its top surface. This results in a chilling of the air which comes in contact with it and the formation of condensation if the cooling is carried on beyond the dew point.

In buildings where artificial humidification is resorted to, or where the humidity is naturally high, this fact means nothing more nor less than that the first ply of roofing on the average roof of this type in this climate is wet during the greater part of the heating season. In a new building moisture may not be evident until some time after erection, due to the hygroscopic property of the roof plank—the wood itself absorbing the condensation if the deposition of the latter, on account of poor air circulation through the cracks, is not too rapid. But on a roof having wide cracks condensation is certain to come sooner or later if the warm humid air of the room below comes in contact with the roofing paper. For this reason the top surface of the roof plank may be seeped with moisture regardless of whether or not any condensation is present on the under surface.



Curves Showing Relative Humidity Which May Be Carried Under Various Types of Roofs Without Condensation Upon Their Under Surfaces.

Again, if cracks between the plank are so wide as to allow moderately free circulation of air, condensation often accumulates so rapidly as to run down the edges of the plank to the room below, manifesting itself in a line of drops at the cracks between the plank. As decay of wood is a direct function of its moisture content, the importance of the foregoing observations is apparent. That is, condensation on the top of the plank is doubtless the direct cause for so much trouble now being experienced at the present time with decaying wood roofs.

If the temperature of the underside of the roof plank coincides with or is lower than the dew point corresponding to the particular humidity and temperature existing, there will be condensation upon this surface and also throughout the thickness of the roof—that is, in the cracks between the plank up to the under side of the roofing paper.

On the other hand, if the temperature of the underside of the roof plank is above the dew point no condensation will be deposited here, but it may occur from the underside of the roofing paper down to a point somewhere within the interior of the roof, depending upon the heat gradient and the relative humidity. Without doubt the presence of this moisture, due to the second cause—that is, within the roof—is a most active agency in providing the proper conditions for the development and rapid spread of disease throughout the roof. In short, the prevention of condensation on the under side of the roof plank, while eliminating a nuisance in manufacturing, may not appreciably lessen the possibilities in the roof for decay.

It has been suggested that enough protection could be added in the form of more wood or other insulating material to the top of a roof to raise the temperature of the upper side of the plank to such a point as to prevent all condensation; and then, providing that data were made available by the forest pathologists as to the limiting conditions of relative humidity which various kinds of wood and different grades of the same wood can resist indefinitely without developing fungi, this information could be used in selecting the roof plank.

Invaluable as the above data on wood would be for use in the design of building interiors, such as beams, columns, floors, etc., these experiments, confirmed by theory, indicate that the prevention of condensation on the top side of roof plank is impracticable for several reasons. First, the insulation would necessarily be so complete as to make the expense unwarranted. Also, if plank were used for this extra insulation they should be antiseptically treated against rot, whereas it will be seen below that a fully satisfactory result will be attained at much less expense by the treatment of the roof plank only. Again, even if condensation within the area in question was prevented by this means, there would still be no certainty that plank selected as suitable for the room conditions would not rot, for the reason that the top side of these roof plank would be several degrees lower than the room temperature. This would result, of course, in a higher relative humidity than that existing in the room below, and consequently plank which might be suitable to resist decay under room conditions would not be so resistant under the actual conditions.

In its last analysis, then, the successful solution of the problem of the design of wood roofs resolves itself into two requirements: The roof should be made thick enough, according to the accompanying curves, to prevent the occurrence of condensation upon its under surface. Secondly, it should be protected against decay by proper preservative treatment.

Contracts were let last week by the Emergency Fleet Corporation for the construction of 39 wooden hulls, 6 standard 8,800-ton Robert Dollar type steel ships, and 3 steel 6,000-ton cargo-carrying steamers. The contracts were distributed among 12 shipbuilders. The total amount represented by the 48 contracts is $22,465,320. The cost of the wooden hulls was placed at $300,000 each, the 8,800-ton steamers at $1,364,000 each, and the three cargo-carrying steamers at $908,440 each.

Bids are now being asked for the construction of three reinforced concrete bridges, the aggregate length of which is over 7,000 ft.

Methods of Constructing Concrete Superstructures for Timber Piers

Owing to the increased cost of timber construction concrete is now being used to a large extent in repairing timber piers or jetties in the Milwaukee District of the U. S. War Department. This work has involved the replacing of the old timber superstructure with concrete. The methods employed in doing this are described by Mr. J. A. B. Tompkins, District Engineer, in Professional Memoirs, from which the matter following has been abstracted:

Concrete superstructures are cellular in type, consisting of two parallel walls connected at intervals of about 8 ft. by cross walls from 12 to 18 in. thick, thereby forming open pockets or "cells" which are filled with rubble stone. The superstructure is built in monolithic sections, 24 or 25 ft. in length, and is provided with a continuous walk of reinforced concrete slabs, supported by the cross walls.

In all cases where an old pier is to be provided with concrete superstructure of this type, the work has been done by hired labor and use of Government plant.

The work of building cellular superstructures on old piers does not require a large or special plant. The plant now being used in the Milwaukee District for such work consists of a floating derrick of 3 to 5 tons' capacity, two flat scows, and a small gasoline tug. A steam-driven concrete mixer, having a capacity of about two-thirds of a yard of finished concrete, is placed on one scow; the other scow is used for carrying materials. With this plant and a crew of about 15 to 20 men, from 200 to 300 lin. ft. of superstructure are built per month, including the cutting down of the old pier.

Care is taken to hold the pile walls together by new wales and binders secured by steel tie rods as the work of cutting down the pier progresses, so as to prevent the pier from spreading. By exercising care, there is no difficulty in holding the pier so as to secure excellent alignment for the concrete superstructure.

Much of the old pile pier in the Milwaukee District consists of two parallel rows of round piles, driven in close contact, secured by wales, binders and tie rods, and filled with stone. The stone is first removed from the pier to the required depth. The piles are then sawed off as close to the water surface as possible. After securing the pier with new wales, binders and tie rods, the stone filling is roughly leveled to about the tops of the wales. The pile heads, projecting about 6 in. above the wales, are then capped with 1 by 12 in. boards, and boxed in on the sides with ½ by 6 in. weather boards, so as to prevent concrete from leaking between the piles.

The forms are then set up and secured in position. The form for a section consists of two outside pieces, two core boxes, and two half core boxes. The general arrangement of the forms is shown in Fig. 1.

An approved form of core box, which has been successfully used, is shown by Fig. 2. This box is so made that it can be readily withdrawn from the hardened concrete. It is built usually of 2-in. plank secured to upright studding, and in four parts, being joined at the middle of the sides. Notches (not shown in Fig. 2) are cut in the longer sides of the box to form the recesses in the cross walls for the slab walk. These notches may be seen in Fig. 1.

The core box is set up on the deck of a scow or other convenient place. After the wedge shaped keys "a" and the struts "d," resting on pins "c" are placed in position, the four parts or corners are drawn firmly together against the shores and wedges by the bolts "b." The box is then placed in position in the form by means of a derrick.

To remove the box from the finished concrete the bolts are loosened, after which the shores are taken out, and the wedge keys removed. The shores are then dropped back into place and the core box is pulled away from the concrete by tightening the bolts until the shores prevent further movement. The box is then lifted by the derrick out of the concrete, as an assembled unit, and is ready for re-setting.

It will be noted that the side walls rest on the round piles, the heads of which are imbedded in the concrete.

Fig. 1—General Arrangement of Forms for Kewaunee South Pier.

While the cross walls are formed on the stone filling, no reliance is placed on the filling as a support for the superstructure. The cross wall is designed as a beam, supported at the ends by the side walls, which in turn are carried by the piles. Each section, therefore, is a complete unit supported by the walls of the pier.

The cross walls are reinforced with steel bars, the purpose of which is not only to enable the walls to act as beams, but also to serve as ties between the side walls. The heads of the piles being imbedded in the side walls, the superstructure holds the pier walls together independently of the rods passing through the wales and piles. Should a section of valving be destroyed or some of the tie rods passing through same be broken, the pile walls would still be held together by the concrete. Short reinforcing bars, placed at 12-in. intervals at the toes of the side walls, enable the concrete to act in tension.

The concrete slabs are molded independently in gang molds, and are reinforced with ⅝-in. square steel bars. The slabs are of a length to span a single opening between cross walls. They are set in the recesses formed in the cross walls on a thin mortar bed, the spaces between ends of slabs being filled with mortar.

Before placing the slabs, the superstructure is filled with stone. It has been the practice recently to spread a thin layer of concrete, about 6 in. thick, over the top of the stone filling. This prevents stones from being washed out by wave action, and also discourages fishermen and others from removing the stone for anchors and other purposes, a practice which in some instances has rather seriously depleted the stone filling.

In some cases the pile pier consists of a row of close round piling on the inner or channel side, and sheet piling with round piles spaced about 4 ft. centers on the outer or lake side. The general method of construction is, however, practically identical with that just described, the sheet piling being cut down to a level with the upper surface of the wales and binders and the piling projecting 6 in. above same and imbedded in the concrete.

The total cost of the concrete superstructures described, including the cost of cutting down and preparing the old pier for reception of the superstructure, has been from about $12 to $15 per linear foot of pier, depending upon the width of pier, which usually varies from 14 ft. to 18 ft. center to center of parallel rows of round piles.

An adaptation of the form of superstructure described has been used for original pier construction. In this case the sides of the pier are alike, consisting of round piles spaced 4 ft. centers, with 9-in. triple-lap sheeting; 12 by 12 in. spreaders are used between round and sheet piles. The general method of construction is the same as that previously described. All work constructed according to this design has been done by contract. The timber, cement, and reinforcing steel were furnished to the contractor by the United States; all other materials were furnished by the contractor. Table I shows the approximate cost of building 100 lin. ft. of this style of pier in this district by contract, including the cost of materials furnished by the United States.

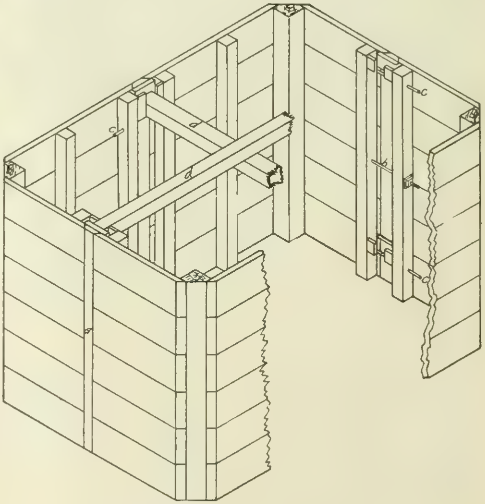


Fig. 2—Approved Form of Core Box.

Concrete superstructure on sheet-pile revetments is built in sections about 10 ft. in length. The work presents no unusual conditions and is similar to that already described. Several hundred feet of this style of superstructure have been built at Sturgeon Bay Canal at a cost of about $3 per linear foot, including the cost of cutting down and preparing the piling for the superstructure. The superstructure has proved entirely satisfactory after 6 or 7 years' experience. No repairs to the concrete have been necessary. In one instance a steamboat ran into the revetment, forcing it back several inches. The waling was somewhat damaged, but no injury was done to the concrete, and the revetment sprang back into place.

In building concrete superstructure on crib piers a slightly different design is used. The cellular type is employed, but foundation blocks are molded on the cribs and the superstructure is then built on these blocks. The crib walls are cut down to about 2 ft. below datum (mean lake level, 1860-1875). Only full courses of timber are removed, however; the timber is removed to that course, the top of which is at or just below the prescribed razee plane.

As the cribs are usually either 50 ft. or 100 ft. in length, superstructure sections are molded in lengths of 25 ft., so that a section will be coterminous with the crib. It has been found when concrete has been built on two cribs, spanning the interval, the lateral movement of the cribs, due to wave action, ruptures the concrete at the interval.

Foundation blocks are molded in place, in lengths of 25 ft. As the bottom of these blocks is usually below the water surface, a canvas dam is used to check oscillation of the water in the form, thereby preventing the cement from being washed out of the submerged concrete while being deposited. The dam consists of a piece of 10-ounce single-filled duck, 8 ft. wide and 28 ft. long. After the form has been set up, the canvas is spread over the timber and stone on which the foundation block is to rest, being held in place under water by stones. The edges of the canvas are then secured to the bottom of the form, using lath battens and shingle nails. The vertical corners of the form are made practically water-tight by tacking on battens, triangular in cross section, with strips of canvas behind them.

It is not advisable to carry the canvas dam up on the sides and ends of the form. To secure good concrete faces, spading against the form is required and at times considerable force is necessary. This spading would tear the canvas and destroy the efficiency of the dam. No attempt is made to have the dam absolutely water-tight or to deposit concrete in the dry; quiescent water is secured, in which the concrete is deposited. With reasonable care, and with waves not exceeding 6 in. in height, very satisfactory results can be obtained.

A convenient method of securing the outside form to the side of the crib while molding foundation blocks, is to nail pieces of 2 by 4 in. timber, each about 12 or 15 in. in length, at suitable intervals along a line about 6 in. from the lower edge of the form, making steps which rest on the crib wall. The old drift-bolts are left projecting above the timber of the crib, and serve not only as anchorage for the concrete blocks, but afford a means of securing ½-in. bolts provided with hooks at one end placed around the drift-bolts, and a nut at the other end. These bolts project horizontally through the side form which, by means of the nuts, is then drawn up tightly against the crib wall. Laths are nailed near the upper edge of the form to mark the upper surface of the concrete, which is roughly finished to that plane. While depositing concrete in the form, the 2 by 4 in. steps are pried off with a spade, the hook-bolts being sufficient to hold the form firmly in place. After the form is removed, the hook-bolts are readily cut off flush with the concrete face by means of a hack-saw.

A similar method is applicable to the walls of the concrete superstructure, old drift-bolts being imbedded in the foundation blocks at the time of molding them. This method of drawing up the form is preferable to using wire, which invariably stretches, causing a leaky form.

Naturally, the cost of superstructure of this type is more expensive than that described for pile piers. By hired labor, however, it has been built on cribs 20 ft. wide for about $18 per linear foot of pier, including cost of cutting down and preparing the cribs.

In some cases it has been desirable to build crib substructures provided with concrete superstructures, as original work. The crib is of ordinary construction, but carried to such height that when sunk on its foundation the timber will be wholly below water. While the crib is afloat at the construction dock, concrete foundation blocks are molded in place. These blocks are made of such height as will insure their upper surfaces being well above water when the crib is sunk in position. On these foundation blocks, cellular concrete superstructure is then built in a manner similar to that previously described.

Unless the height of the crib is very considerable, the foundation blocks will cause the crib to sink unless further buoyancy is supplied. This is readily done, however, by placing water-tight boxes, open at the top, in the pockets of the crib.

Each box is provided with four 2-in. holes in the bottom, which are stopped by long-handled plugs reaching to the top of the box. The crib is sunk in position by admitting water into the boxes through these holes. When the boxes are full of water the crib usually rests securely on the foundation; but in case it does not, sufficient stone ballast is placed on the concrete blocks to anchor it firmly on the foundation before filling the pockets with stone. After the crib rests firmly on the foundation the boxes are released and lifted out by a derrick, the water running out through the holes in the bottom as the box is slowly raised. As soon as the boxes have been removed, filling the crib with stone is commenced.

The following tabulation shows the size, number of boxes, etc., which have been used in actual construction:

	Size of one box			Displacement per box.	No. of boxes used.	Draft of crib.
Size of crib.	Length.	Width.	Height.	Tons.		Ft.
100' × 24' × 14½'........	6' 8"	6' 5"	6' 6"	5.5	5	13
100' × 24' × 12½'........	6' 8"	6' 5"	6' 6"	5.5	7	11
100' × 20' × 10½'........	6' 8"	5' 3"	6' 6"	4.5	12	9
100' × 20' × 8½'........	6' 8"	5' 3"	6' 6"	4.5	14	7

The cost of one crib, 100 ft. by 24 ft. by 14½ ft., complete with superstructure, but exclusive of foundation and riprap, at contract prices prevailing in this district, is about $7,850.

This method of construction has proved very satisfactory. About 1,700 lin. ft. have been built, of which 400 lin. ft. was provided with solid instead of cellular superstructure.

TABLE 1—APPROXIMATE COST PER 100 LIN. FT. OF PILE PIER WITH CONCRETE SUPERSTRUCTURE.

		17-ft. pier—16-ft. water.		14-ft. pier—12-ft. water.		11-ft. pier—8-ft. water.	
Materials.	Unit cost.	Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Round piles, lin. ft..........	$ 0.37	1,450	$ 536.50	1,250	$ 462.50	1,050	$ 388.50
Sheet piles, ft. b. m..........	44.00	39,600	1,742.40	32,400	1,425.60	25,200	1,108.80
Timber, ft. b. m..........	47.50	10,633	505.07	10,633	505.07	8,033	381.57
Bolts, spikes, etc., lbs..........	.05	3,761	188.05	3,412	170.60	3,064	153.20
Concrete superstructure, cu. yds..........	10.50	98	1,029.00	93	976.50	87	913.50
Concrete slabs, cu. yds..........	12.00	12	144.00	6	72.00	6	72.00
Reinforcing bars, lbs..........	.02	3,249	64.98	2,303	46.06	2,003	40.06
Stone—filling and riprap, tons..........	1.60	2,000	3,200.00	1,100	1,760.00	425	680.00
Cost of 100 lin. ft. of pier..........			$6,904.93		$5,418.33		$3,737.63

Condition of the Steel Work in Building After 7½ Years' Life

Interesting notes on the condition of steel work in a building demolished after a life of only 7 or 8 years are given in the last annual report of the Bureau of Buildings of New York City. The information relates to the Hoffman House and Albemarle Hotel, which were removed to make place for a high commercial building.

The old building was located on the northwesterly corner of Broadway and 24th St., New York City, and consisted of a 7-story and cellar non-fireproof structure. Adjoining and surrounding the same was a 12-story fireproof building used in connection with the hotel. This latter structure occupied an L-shaped lot with frontage on both Broadway and W. 24th St. Records in the Bureau show construction was commenced October, 1906, and completed in December, 1907. In July, 1915, a permit was issued for the demolition of the building, making in all 7½ years as the extreme age of the structure.

The walls were of the skeleton type, 12 in. thick for the uppermost 75 ft. of height and thence increased 4 in. in thickness for each lower 60 ft. or fraction thereof. For floors, 9 and 10-in. terra cotta flat arches sprung between steel beams were used, with the usual 2-in. cinder fill between the sleepers and a double wood flooring. The partition walls throughout the building were of terra cotta blocks plastered on both sides. All interior columns were encased in 2-in. terra cotta block while the customary 4 and 8-in. of brickwork was used for exterior and wall columns.

The foundation consisted of concrete piers in open caissons carried down to rock at a depth of about 37 ft. below curb. It appears that during the construction of the foundation, considerable ground water was encountered, necessitating the use of steel sheet piling. A great deal of this sheeting was uncovered, especially where it interfered with the new work. The sheeting for the most part was intact and showed very little corrosion. In fact in many places the smooth, even surface of the black iron was plainly visible. Whether the absence of rust was due to the comparatively short period that the sheeting was in place (a little over 7 years) or whether it was due to the drawing away of the ground water by the new subway construction, is hard to say. Evidently both contributed toward the preservation of the metal.

Along the northerly wall a number of timber piles were uncovered. Their age is unknown, but the action of rot due to the absence of water was remarkably illustrated. On some of the piles the entire mass had rotted away except the heart wood.

At the time of the erection of the 12-story building, it was found necessary to underpin the west wall of the old Hoffman House. This was done with steel cylinders driven in 5-ft. lengths to rock and filled with concrete. These piles, however, showed practically no rust.

Throughout the entire structure the absence of any cases of severe rusting of the steel work was apparent. The steel appeared to have been given originally two coats of paint, and in most cases the coating was intact without the slighest sign of corrosion. Practically the only places where rusting did take place was the outer face of the exterior columns in the easterly court wall. This wall was exposed for almost its entire height to weathering conditions. In all probability, the 8 in. of brick encasing the outer face of the column would have been sufficient to protect the steel from moisture but for the fact that the outside 4 in. of the wall was face brick. The unfilled space between the face brick and the backing appears to have aided the collection of moisture and also to have retained it. At and near connection, the conditions were worst, but in no case sufficient to impair the strength of the metal.

At the outer faces of a wall column on the Broadway front on the seventh floor, rust formation could be readily noticed on the outer channel and plate. These sides were protected from the weather by brickwork and ashar facing, but apparently water was able to percolate through the joints and attack the steel. The coating of paint had already peeled off in some places, but the corrosion had not progressed to a point where the strength of the steel might be considered impaired. The fact that these columns had already begun to show signs of rust at the age of only 7 years would tend to prove that more protection is necessary for wall columns than the customary coating of paint.

The inner faces of wall columns were all in very good condition and did not show signs of corrosion.

The faces of inner columns were smooth and even, with not the slightest sign of rust on their surfaces. The coating of paint was unscarred.

In the case of steel sheet piling where the metal came in contact with the soil, corrosion could be readily noticed, but not to an extent sufficient to impair the strength of the steel.

The examination indicated that the exterior wall girders and the outside faces of the wall columns seem to be the vulnerable points for corrosion in the steel work of skeleton buildings.

Saw Tooth Roof Construction

A building, adding nearly 3 acres of floor space to the plant of Colt's Patent Firearms Co., was completed a few days ago by the Aberthaw Construction Co. of Boston, Mass.

The building is a 1-story structure, covered by a sawtooth roof. The bay spacings are about 21 ft. each way. The sawtooth roof runs lengthwise of the building so that the glass area is exposed to a northerly light. The sawtooth framing is structural steel supported on round steel columns, there being some 260 tons of structural steel used. Outside columns and the floor, which are of reinforced concrete, called for 350 tons of reinforcing steel. Heavy reinforcement was necessary in the floor on account of bad ground conditions. Over 220,000 brick and 10,000 sq. ft. of Fenestra steel sash were used for the outside walls. Van Noorden metal windows were used in the sawtooth roof.

Roof Construction for New Factory Building of Colt's Arms Co.

Effect of Sand Grading on Strength of Concrete

A series of tests was conducted in 1916 by the Department of Works of Toronto, Ont., to secure information relating to the effects of grading of sands and consistency of mix upon the strength of concrete. The investigation was made under the supervision of Mr. L. N. Edwards, who outlined the results obtained in a paper presented at the last annual meeting of the American Society for Testing Materials. His conclusions based on the results and the phenomena observed were as follows:

The commonly practiced "visual examination" test of sand aggregate for concrete is generally unreliable, since it gives at best only a superficial knowledge of the cleanliness of a given sand. Its adaptation to the determination of grading could be of value to the observer only after long experience in the granulometric analysis of sands.

The generally accepted practice of proportioning a concrete mix by volume, as, for example, 1 part cement, 2 parts sand and 4 parts broken stone, is impracticable and unscientific, since it does not take into account the adaptability of the grading of a given sand to the production of a dense, strong, and reliable concrete. Proportioning by volume, as commonly used, gives no guarantee of the production of a concrete having a desired strength, hardness, or other physical properties.

The strength, toughness, and durability of the concrete to be secured from the use of a given sand can be determined only by an actual test of that sand in a properly prepared concrete.

In field operations incident to spading, slicing, or otherwise compacting the concrete, the movement of the water content of the mass is intensified, whenever the sand aggregate contains insufficient fine material to hold the cement in suspension by the formation of an adequate amount of sandy paste. The free movement of the water tends to produce an improper distribution of the cement.

The use of a quantity of water sufficient to produce a concrete, the mortar component of which is of a saturated, sticky, semi-plastic consistency, is for most practical purposes required, in order to facilitate economical and efficient placing. This quantity of water is ample for the development of the proper functions of the cement. An increase in the quantity of water used results in a proportionate decrease in the strength of the concrete. This decrease is in no sense a function of the proportions of the mix.

The excess water in an over-saturated concrete necessarily occupies space and thereby bulks-up the mass. By reason of its high surface tension, it forms water globules which, although somewhat affected by the weight of the concrete, are nevertheless distributed throughout the mortar component and are accumulated underneath the particles of the sand and stone aggregates and the reinforcing steel. By evaporation, this excess water ultimately disappears, leaving a considerable volume of water voids and cavities which constitute an extremely important factor in the strength and reliability of the concrete.

The critical failure of reinforced concrete depends upon the intensity of the bond existing between the concrete and the steel reinforcement. Concrete containing an excess of water not only develops less surface contact with the steel on account of the resulting increase in the volume of water voids and cavities; but, in addition, the excessive laitance produced by the water tends to accumulate around the reinforcement, thus contributing materially to a decrease in strength. This condition becomes further aggravated by reason of the tendency of the laitance to become less resistant with age.

For the various grades of concrete, the minimum ultimate strengths assumed in the modern practice of plain and reinforced-concrete design are not assured by the commonly specified requirements for sand and stone aggregates, and by the present lack of uniformity and of efficiency in field methods and operations.

The results obtained show no definite relation between the compressive strengths of 1:3 mortar cubes, and the compressive strengths of the concretes produced from the same sands.

How a Big Construction Company Keeps Its Building Material in Order

Those contractors who have carefully studied all the details of their business realize the convenience as well as the economy of very carefully planning in advance with regard to the delivery of material on the site. Among those who have given special attention to this subject as displayed in numerous cases is the Aberthaw Construction Co. of Boston.

In advance of beginning work a plan is made in which consideration is given to the track or road facilities, proximity of material to the building, means of handling from one point to the other, and hoisting to position, as well as the relation to the woodworking plant.

Layout of Form Lumber for Construction Job.

In the case of form lumber, for instance, lumber of a stated size is kept together—in fact, so far as possible it is ordered of the exact length required for the given form. Likewise, storage facilities are established for brick, stone, sand, cement, etc.

The accompanying illustration shows such a layout, the lumber carefully piled. In the foreground is the routing office. Showing above this office and in the background is the sawmill, while in the left foreground are the engineer's and foremen's offices, the tool room, etc.

As lumber arrives on the job it is piled in the most convenient position for carrying to the sawmill. From the mill it passes forward to the place where it is to be used.

A Building Every 46 Minutes the Construction Record at the Fort Sheridan Cantonment

A notable record was made in the building of the wooden cantonment at Fort Sheridan, Ill., for the reserve officers' training camp. The project involved the construction of 80 structures. Work was actually started on the morning of May 1 and the buildings were ready for occupancy and the sanitary system in operation on the evening of May 10.

Twenty-one companies, each of about 160 men, were quartered in the cantonment. The quarters for each company consisted of four buildings placed end to end with a 20-ft. space between each. Two of these structures were the barracks, each containing cots for 80 men. The other buildings in the group were the mess hall, with kitchen, and the lavatory.

The job consisted of the construction of 42 barracks 20x126 ft. each; 21 mess halls and kitchens 20x112 ft. each, equipped with tables and benches; 21 lavatory buildings 16x63 ft. each, equipped with toilets, shower baths, etc.; 1 postal exchange building 20x30 ft., and 1 telephone exchange building 20x33 ft. The undertaking also included the laying of 3,400 ft. of sewer at an average cut of 5 ft., the installing of approximately 4,500 ft. of water main, 3,800 ft. of water laterals, and the necessary plumbing, and the installation of electric lights.

The sewers were connected to the existing sewer system of Fort Sheridan, and the water supply was obtained from the regular supply at the post. The trenches for the sewer and water lines were dug by two trenching machines—a Dalton and an Austin. Universal pipe was used for the water mains.

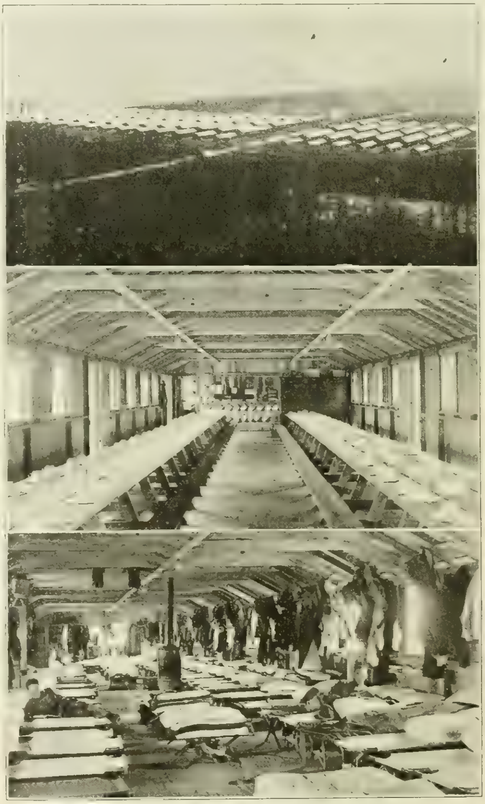
The site of the cantonment is an open field sloping at about 3 per cent grade to the north and east. The soil consisted of 3 ft. of brown loam underlaid with stiff clay. The weather at the time of construction was cold, but for the most of the time was clear.

The construction of the buildings was done by contract, as also was the plumbing. When the job was figured the contractor had his estimating department take off exact details as to the lumber list, mill list, requirements for roofing, and requirements for concrete construction. This took two men four hours, but it would save a duplication of work and that amount of time after the contract was awarded. Preliminary arrangements had been made for the purchase of this material, and within one hour after the contract was awarded the contractor had bought 95 per cent of the material required. This meant 60 cars of lumber, 30 cars of sand and gravel, 4 cars of cement, 300 specially constructed ventilators, 600 doors, 1,200 windows and 2,500 squares of roofing.

The construction contract was let on Saturday evening, April 28, and about noon of the next day the order for 1,400,000 ft. of dressed lumber had been placed. During the afternoon 5 motor truck loads of lumber were dispatched to Fort Sheridan to provide quarters for the working forces engaged on the job. The next day the entire 1,400,000 ft. of lumber was shipped. Thirty teams and 5 motor trucks transported the material from the team track about 1 mile to the site as required.

The necessary rearrangement of the contractor's organization was made the afternoon of the award of the contract, and the following morning he had at Fort Sheridan three motor trucks with equipment, five motor trucks with foundation timbers, four superintendents for the different branches of the work to be done, and 22 foremen. All this was accomplished without employing new men in the organization.

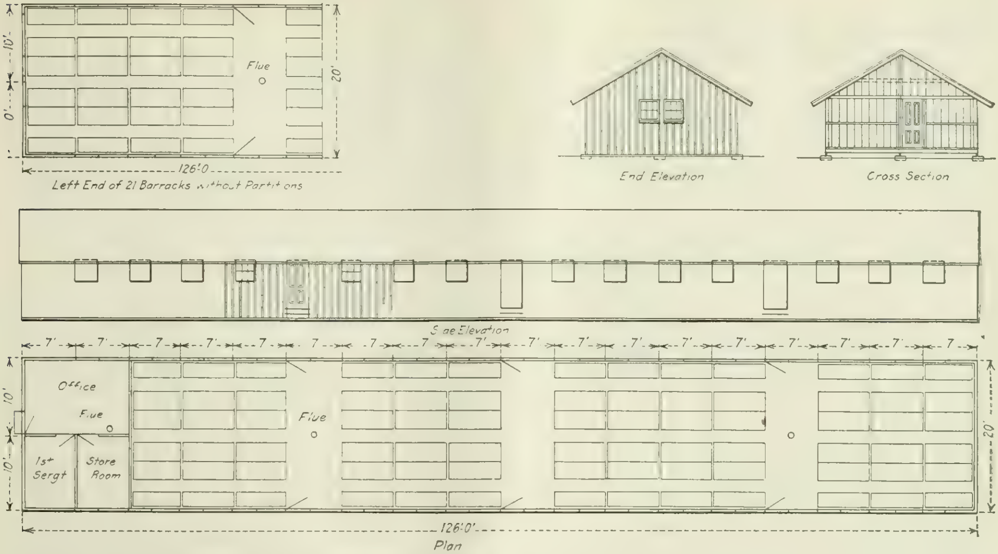
One thousand feet of industrial track and two power saws were immediately laid out ready for use. Corner stakes were set, grades taken, and all preparations made for commencing construction the second morning. From 300 to 500 mechanics were thereafter employed, and the necessary common labor for distributing the material from the saws to the required places by means of wagons and the industrial railroad. On account of the deep mud the industrial railroad was an absolute necessity at the start, although while the work was going on the weather was dry, though windy and cold. With the job organized in this way it was possible to complete a building at an average time of 46 minutes.



Top View—Military Training Camp, Fort Sheridan, Ill., on May 14, 1917. Middle View—Mess Hall. Bottom View—Sleeping Quarters.

Approximately 750 men were employed, working one shift per day. The Sumner Sollitt Co. of Chicago was the general contractor for the buildings. Stein Bros. Co., Chicago, was the contractor for the plumbing.

Josiah L. Rice, superintendent of construction at Fort Sheridan, had general supervision of the work. He was assisted by men from Company B, First Ohio Engineers, N. G., under the general supervision of Capt. Frederick P. Troyan.



Floor Plan Side Elevation and End Elevation of Barrack for Reserve Officers' Training Camp, Fort Sheridan, Ill.

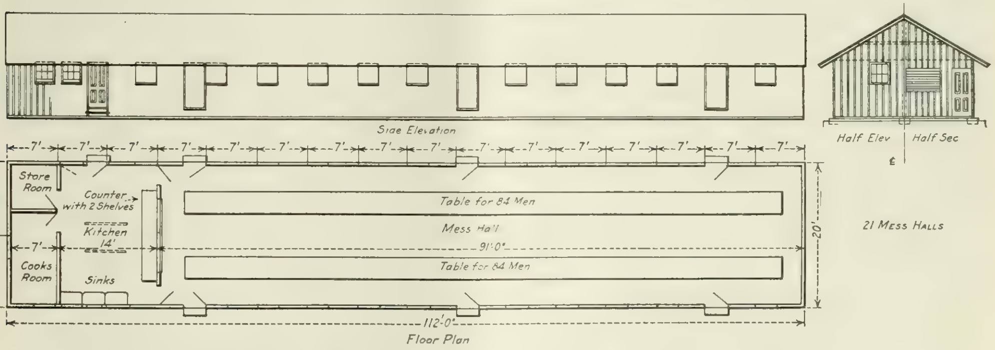
BILL OF MATERIAL FOR 126-FT. BARRACK.

Lumber.

Size.	Length.	Description.	Pieces.	B.M.
6 in. x 6 in.	......	Foundation posts	...	....
2 in. x 6 in.	14 ft.	Sills, girders, plates........	144	2,016
2 in. x 6 in.	10 ft.	Joists, plates (ends only)....	380	3,800
2 in. x 4 in.	14 ft.	Rafters	296	2,628
2 in. x 4 in.	14 ft.	Studs (ends, high partitions).	6	54
2 in. x 4 in.	8 ft.	Studs (sides and jambs)....	111	542
2 in. x 4 in.	14 ft.	Girts (sides and long partitions)	39	349
2 in. x 4 in.	10 ft.	Girts (ends, cross partitions)	21	140
1 in. x 12 in.	8 ft.	Boards (sides)	546	4,368
1 in. x 12 in.	12 ft.	Boards (ends, high partitions)	22	984
1 in. x 12 in.	14 ft.	Boards (ends, high partitions)	18	252
1 in. x 6 in.	14 ft.	Boards (ridge, tie beams, window sills)	138	966
1 in. x 3 in.	8 ft.	Battens (sides, etc.).........	596	1,192
1 in. x 3 in.	10 ft.	Battens (ends and partitions)	50	140
1 in. x 3 in.	14 ft.	Battens (ends and partitions)	108	392
½ in. x 1½ in.	12 ft.	Stop boards (for doors and windows)	146	292
⅞ in. x 3 in.	......	T. & G. flooring..............	...	9,048
1 in. x 8 in.	......	Ship lap for roof............	...	8,470
2 in. x 6 in.	12 in.	Footings	456	456
1 in. x 2 in.	......	To attach netting............	...	84

Miscellaneous Items.

Description.	Quantity.
7-in. fire clay around flue..................................	7
9-in. G. I. smoke pipe..	7
1 lb. No. 4 B. & S. gage wire for each flue, lb...........	7
6 light 10 in. x 16 in. single sash, glazed..................	62
3-in. hook eye for each sash..................................	62
2 ft. 8 in. x 6 ft. 8 in. 1⅜-in. 4-panel doors............	15
6-in. T-hinge	30
4¼ x 3¼ rim lock knobs.......................................	15
16d nails (framing), lb..	192
6d nails (floor, boarding and roof), lb......................	202
3d nails (battens, stop beads), lb............................	104
Roofing paper, rolls...	72
No. 14 mesh heavy screen wire................................	...



Floor Plan, Side Elevation and End Elevation of Mess Hall for Reserve Officers' Training Camp, Fort Sheridan, Ill.

BILL OF MATERIAL FOR 112-FT. MESS HALL.

Lumber.

Size.	Length.	Description.	Pieces.	B.M.
6 in. x 6 in.	......	....	...	...
2 in. x 6 in.	14 ft.	Sills, girders, plates.........	64	896
2 in. x 6 in.	10 ft.	Joists, plates (ends only)...	170	1,700
2 in. x 4 in.	14 ft.	Rafters	130	1,170
2 in. x 4 in.	14 ft.	Studs (ends, partitions)......	6	54
2 in. x 4 in.	8 ft.	Studs (sides, jambs)........	48	264
2 in. x 4 in.	14 ft.	Girts (sides, partitions).....	19	171
2 in. x 4 in.	10 ft.	Girts (ends, partitions)......	16	104
1 in. x 12 in.	8 ft.	Boards (sides, partitions)...	239	1,882
1 in. x 12 in.	12 ft.	Boards (ends, partitions)....	64	768
1 in. x 12 in.	14 ft.	Boards (ends, partitions)....	12	156
1 in. x 6 in.	14 ft.	Boards (ridge, tie beams, window sills)	61	427
1 in. x 3 in.	8 ft.	Battens (sides, ends, partitions)	264	528
1 in. x 3 in.	10 ft.	Battens (ends, partitions)...	32	80
1 in. x 3 in.	14 ft.	Battens (ends, partitions)...	51	179
½ in. x 1½ in.	12 ft.	Stop beads (for doors and windows)	76	152
⅞ in. x 3 in.	......	T. & G. flooring..............	...	2,724
2 in. x 4 in.	10 ft.	Bents and braces (for tables)	32	215
2 in. x 4 in.	12 ft.	Legs and braces (for tables)	26	208
2 in. x 10 in.	14 ft.	Seats (for tables)...........	24	560
1 in. x 12 in.	14 ft.	Tops (for tables)............	36	504
1 in. x 8 in.	......	Ship laps	...	3,760
1 in. x 2 in.	......	For attaching screens.......	...	240
2 in. x 6 in.	12 in.	Base plates	144	144

Application of Magnetic Analysis to Study of Steel Products*

It is well known that two pieces of steel which differ in any one of a number of particulars show correspondingly different mechanical properties. It is well supported by experimental evidence, but not so generally known, that two pieces of steel which differ in certain particulars, likewise show corresponding magnetic differences.

The changes that are brought about by adding certain chemical constituents to steel are well known. In many cases the corresponding magnetic properties have been studied. With increasing carbon content in a hypo-eutectoid steel there is an increase in hardness and tensile strength and a decrease in toughness. Magnetically an increase in carbon content is accompanied by an increase in coercive force and hysteresis, and a decrease in permeability. Many other cases might be cited.

Mechanical operations also bring about corresponding changes in both the mechanical and the magnetic properties of steel. The cold drawing of a carbon steel increases its tensile strength and simultaneously increases its coercive force and hysteresis. Cold drawing also decreases the magnetic permeability.

The influence of heat treatment upon the properties of steel is fairly well known. A 1 per cent carbon steel quenched in water from a temperature above its critical point has a greater tensile strength than the same material in the annealed condition. Its hardness is also increased while its toughness is greatly decreased. Magnetically, changes of equal magnitude also occur on quenching. The quenched steel has a greater coercive force, a greater hysteresis, and a lower permeability.

In a specific case a 1 per cent carbon steel in the quenched and the annealed conditions had Brinell hardness numerals, in terms of kilograms per 0.1 mm. indention of 4390 and 800 respectively. The corresponding values of the coercive forces for a magnetizing force of 150 gausses were 33 and 12.

Steel changes with lapse of time. The course of this change is not so well known as some of the above changes. However, both mechanical and magnetic changes occur. Glass-hard steel softens with age. The same steel shows a decrease in coercive force.

The mechanical properties of a bar of steel may differ from point to point if the bar has not received the same treatment throughout. For instance, if a uniform bar is given a slight bend and again straightened it will show a slight change in its mechanical properties. There will be an increase in both hardness and tensile strength. The same bar will show a corresponding decrease in permeability in the same region.

Even during the operation of stressing a bar we feel sure that changes in the mechanical nature are occurring. Less is known about this phase of the problem than the preceding. However, we do know that small alternating stresses, even though well within the elastic limit, leave the material mechanically fatigued and if the stresses are repeated often enough rupture occurs. While it is difficult to study the changes in mechanical properties after repeated or alternating stresses, the magnetic problem is quite simple and has been investigated to some extent.

Magnetic analysis may be applied to determine the nature of the steel as a raw material, as a finished product, or even after it has been subjected to service conditions.

It is obvious that one cannot get a good product from inferior materials. Consequently it is desirable to know the nature of the raw stock that enters into the construction of the finished product. In this classification of raw material and finished product, it must be recognized that what is raw material from one point of view is the finished product from another. The rod is a finished product as viewed from the standpoint of the rod mill. The manufacturer of ball bearings, however, looks upon the rod as a raw material.

Raw material must be uniform in quality. The proper mechanical and thermal treatment must be determined for each steel that is used. It very frequently happens that two steels of quite different composition may give equally good performance for a particular service provided each steel is given the appropriate heat treatment. In general the heat treatments required for the two steels will be different. Consequently if the heat treatment appropriate to the second steel is given to the first, disastrous results may be expected. It is desirable, therefore, that all the different bars of a given lot of material shall be of the same quality as the material for which the proper heat treatment was determined. Such assurance requires the examination of every individual bar of steel.

The requirements that all bars shall be alike in properties, implies that each bar shall have the proper composition, shall be properly forged, rolled or drawn, as the case may be, and shall be free from local imperfections such as blowholes, segregation, etc.

Occasionally a lot of steel of the wrong composition is supplied through error; or, by some chance, a single bar of different composition may get mixed up with the general stock. If not detected such a bar may cause much loss or annoyance. Very frequently a steel, especially among the alloy steels, may have the proper chemical composition but with the elements not in the proper state of solution. It is not uncommon to find that a tool made from a large bar will prove defective while the same bar when forged down to a smaller size will yield perfect tools. Since the cost of labor frequently amounts to more than the cost of material, it is very desirable to be able to separate the good from the defective material before costly labor has been put upon it.

Another defect that sometimes is found in cold-drawn material is the tearing apart of some of the crystals beneath the outer surface.

Many of these defects would pass unnoticed in the usual examinations by the chemist, microscopist, or mechanical tester. In such cases as the above a magnetic examination may be expected to be of service.

The ideal test of a finished product is one which permits the examination of each individual and does not assume that the characteristics of 99 pieces are identical with those of the hundredth one which happened to be picked out for test. Magnetic analysis is adapted to such individual testing. The individual test not only permits the elimination of defective pieces but also permits the grading of a product which, while satisfactory in general, is not all of the same degree of perfection. It is a matter of common experience that an occasional tool is found which is quite superior to the average fairly good tool. Any method which will enable one to select such exceptionally good tools cannot fail to be helpful. This process of grading will enable the manufacturer to offer a uniformity of product hitherto unknown and permit him to guarantee such uniformity with surety. It is true that certain tools will have to be sold as seconds at a reduced price. On the other hand there will be a new class of exceptional quality which will bring a correspondingly higher price.

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*From a paper by Charles W. Burrows presented at the last annual meeting of the American Society of Testing Materials.

The individual test will permit improvement in design. At present we insist upon factors of safety so large that there would be a reasonable factor of safety even though there were a considerable amount of defective material. If a material is used whose individual properties are not known and which may vary between wide limits a greater factor of safety is used than if known material were used. For example, a cast-iron structure might have a factor of safety of ten while a similar structure of steel would be safe with a factor of four or five.

Frequently it is desirable to make exhaustive tests upon a few pieces. Such cases arise where one or more samples are submitted in competition with other material. I recently witnessed a test on the results of which an order of $200,000 was to be based. Five pieces worth about $2.00 each were submitted by each competitor. The properties of each sample depended upon proper composition and proper heat treatment. Even though the composition were correct a slight error in the heat treatment would place the material at a disadvantage. By a suitable magnetic test the manufacturer could have assured himself that his samples were representative of his best product.

I have made laboratory tests on a number of commercial articles with considerable success. Experimental evidence already at hand shows that it is feasible to apply individual magnetic tests to many forms of tools, cutlery and springs. These tests are of such a nature that they may be carried out on a commercial scale. Rings and balls for ball bearings are now being tried out by this method with every promise of success. Steel rails, in spite of their size, lend themselves very readily to this method of examination.

Since the magnetic and mechanical properties of steel suffer changes with the lapse of time and under ordinary service conditions, the magnetic method offers a very promising means of examining, without destruction, the changes that develop during the life history of a structure. Some of the things to be looked for are the ordinary results of wear and tear. A good example of this is the mine or elevator cable. Such cables grow old and lose their usefulness or even become a source of danger due to the wearing away of the material, the breaking of strands, excessive strains, the development of a crystallin structure, etc. The causes of deterioration of a cable are so numerous and the possibility of disaster frequently so great that it is customary to replace an old cable by a new one while several years of usefulness remain in the cable. A proper magnetic test would keep the cable under surveillance at all times and make an autographic record.

A structure may fail by the development of flaws. For instance, a steel rail may render apparently satisfactory service for several years and finally develop a transverse fissure which results in a dangerous accident. Periodic examinations of rails which are under suspicion because of excessive duty or other causes may be made and we may thus detect the presence of such a flaw in an early stage of its development.

Magnetic analysis may be of use in the development of a new design. It is customary when a new design or a new model is developed to run a service test and at intervals to dismantle apparatus and go over in detail the various members of the structure. This procedure is common in high-grade mechanisms such as automobiles, adding machines, etc. Such an examination will detect errors in design or faulty material which result in fracture or excessive wear. They do not, however, indicate the structure of a part which is just about to break. A magnetic test may be expected to follow the changes in structure from the initial perfect condition, through the various stages of fatigue, to the final rupture. Such changes would be indicated magnetically, whether they were due to a gradual return to a crystallin equilibrium or to stress effects.

Another field which has not as yet been tried but for which the possibility has already been established is in the study of the state of stress of a given structural member. For instance, it may be desired to determine whether a given member in a bridge undergoes tension or compression during the passage of a train. The fact that steel suffers certain changes in its magnetic properties when put under tension and certain other changes when put under compression renders such a determination possible.

The apparatus required and the procedure of testing depends to a great extent upon the nature and size of the material tested as well as upon the characteristic flaws to be expected. Apparatus for examining safety-razor blades is necessarily quite different, notably in size, from apparatus for the testing of steel rails. In the case of a lathe tool in which only the nose is hardened the examination differs from that of a locomotive driving rod which is more nearly uniform throughout.

If the testing of rails is to give a certainty of the quality of the material, it is necessary to test not only each rail but every element of the length of each rail. This may be accomplished by a double magnetic test. One part of the magnetic test will determine whether there are non-uniformities along the length of the rail. Since this test is based upon a determination of magnetic leakage it is referred to as the "leakage" test. The leakage test determines the homogeneity of the rail. Inhomogeneities, while they may not be due to dangerous imperfections, always cast suspicion upon the rail. Inhomogeneous rails should not be used in places where the highest degree of perfection is required. For instance, inhomogeneous rails should not be used on bridges, in tunnels, or where the traffic is heavy. Homogeneity in itself is not evidence of perfection. A rail may be quite uniform along its length and yet be an unsafe rail. Its dangerous nature may be due to improper chemical composition or to errors in the process of manufacture, such as improper finishing temperatures or excessive cooling rates. To determine whether or not such defects exist requires a determination of one or more magnetic constants. These measurements may be made in some form of permeater and in conformity with the nomenclature for similar tests on small specimens, we call this part of the magnetic examination the "induction" test.

A magnetizing solenoid is moved along the length of the rail. Any non-uniformity along the rail will cause a variation in magnetic leakage. This variation in leakage develops a small electromotive force which is approximately proportional to the degree and sharpness of the non-uniformity. A special recording voltmeter makes a photographic record of the magnetic inhomogeneities. This examination of a rail can be made in about 1 minute and excessive demands for skill and training are not made upon the operator.

The induction test is fairly simple. The most useful magnetic quantity is probably the coercive force. For the purpose of illustration we may give the coercive forces of two lots of rails of substantially the same chemical composition, made at the same mill, and differing only in their method of cooling. Four rails rolled in winter were from the first ingot which passed through the mill in starting the round for that particular date. Consequently these rails were the first upon the hot bed which was initially cold. Two other rails of substantially the same chemical composition were selected from a full hot bed and from the middle of a round rolled when the atmospheric temperature was 70° F. The averages of the coercive forces for a magnetizing force of 145 gausses were 10.30 gausses for the winter rails and 8.91 gausses for the summer rails. This difference of 1.39 is probably due in great part to the difference in the rate of cooling of the two sets of rails.

The fundamental fact that there is a definite relation between the magnetic and mechanical properties of steel is so well established that the successful application of magnetic analysis to commercial testing is assured. In any particular case the apparatus must be developed and operators trained. However, the difficulties presented are not excessive. Before shop methods of examination of any given product can be installed, a preliminary investigation must be carried out which involves five steps.

1. Magnetic data of representative material must be determined. Good, bad and indifferent materials must be examined and the data thus obtained correlated so that one may know what magnetic characteristics go with each grade of material.

2. From the mass of data thus obtained the most suitable magnetic criteria must be determined. In some cases any one of several magnetic constants may be equally satisfactory. In other cases only one specific constant may be used. Still others may require the combination of two or more magnetic constants.

3. Suitable apparatus must be designed. After the proper criteria have been determined the next step is to detemine what type of apparatus is best suited for the particular material to be tested. Ball-bearing rings will, for the most efficient operation, require a slightly different piece of apparatus from that required by twist drills.

4. Limits of quality must be determined. Since the proper combination of speed, cost and accuracy may call for some slight deviation from the ideal theoretical considerations, the material to be tested must be examined by the final form of apparatus. From these data the final criteria of quality must be determined.

5. The final step of this preliminary investigation is the reduction of all the operations to mere routine, so that shop determinations may be made by an observer who is not necessarily an investigator.

Bids Asked on Two Bridge Jobs Requiring 65,000 Cubic Yards of Concrete and 5,000,000 Pounds Reinforcing Metal

Bids are now being asked for the construction of two notably large reinforced concrete bridges. One of these structures is to be erected at Akron, O., and the other at Columbus, O. The latter is to be built over the Scioto River at Mound St. It will consist of 9 arches of the barrel type and of the following lengths: Two of 77 ft., two of 86 ft., two of 94 ft., two of 102 ft., and one of 110 ft. The length of the bridge over all is 1,049 ft. The width over all will be 50½ ft., roadway curb to curb being 40 ft. There also will be two sidewalks each 6 ft. wide. The bridge will have a spread of 45°. The estimated quantities includes the following items:

Excavation, cu. yd.	82,160
Concrete, cu. yd.	24,179
Reinforcing steel, lb.	880,000
Waterproofing, sq. yd.	2,200
Gravel fill over arches, cu. yd.	9,100
Arch barrel facing, sq. ft.	4,650
Scrubbed finish, sq. ft.	9,300
Tooled finish, sq. ft.	31,700

Bids on the Mound St. bridge will be received by County Commissioners at Columbus, O., until Aug. 29. Braun, Fleming & Knollman, Columbus, are the Consulting Engineers and John Peake is the County Surveyor. The Akron bridge is to be built for Summit County. It will extend in a northeasterly direction from the intersection of Main and Furnace Sts. of the city of Akron. The viaduct will have a total length 2,791 ft. and includes 16 arch spans varying in length from 116 ft. to 191 ft. (totaling 2,483 ft. in length) and eight girder spans at the south end totaling 171 ft. and four girder spans with a total length of 137 ft. at the north end.

The arch spans will be supported on 17 concrete piers, some of them resting on concrete piles and some founded on sand and gravel. The girder spans are supported on columns whose footings are founded on sand and gravel. Traffic provision on the viaduct will consist of two sidewalks, each 10 ft. wide, and a paved roadway 52 ft. between curbs, giving a total clear width of 72 ft. Provision will be made in the central 18 ft. of this roadway for the installation of two electric railway tracks. These tracks over the pavement of the structure, however, are not a part of the present contract. Over the south girder spans the structure will have a total width of 100 ft., made up of a roadway 76 ft. wide and two sidewalks each 12 ft. wide.

The approximate quantities include the following items:

Concrete piles, lin. ft.	74,950
Concrete for footings, cu. yd.	7,230
Concrete in pedestals, cu. yd.	4,840
Other concrete, cu. yd.	29,400
Reinforcing bars and other reinforcing metal, lb.	4,200,000
Miscellaneous metal, lb.	232,000

Bids for this viaduct will be opened on Sept. 10 by the County Commissioners at Akron, O. Harrington, Howard & Ash, Kansas City, Mo., are the Consulting Engineers.

Personals

C. C. Cottrell has been appointed assistant highway engineer of Nevada.

William F. Moore, for the past 2½ years City Engineer of Grand Rapids, Mich., has been appointed State Highway Engineer of Indiana.

J. H. Prior, formerly chief engineer, Illinois Public Utilities Commission, has left the service of the Illinois Commission to open an engineering office in Chicago.

R. L. Kenan and Fulton Pace have entered into a partnership under the firm name of Kanan & Pace, and will engage in a consulting practice, specializing in highway work.

Professor Milo S. Ketchum, Dean of the College of Engineering of the University of Colorado, was elected President of the Society for the Promotion of Engineering Education for the next year at the annual meeting of the Society held at Washington, D. C., July 6th and 7th, 1917.

M. E. Allen and R. W. Baily have entered into a partnership under the firm name of Baily & Allen Co. Mr. Allen was secretary and contracting engineer for the Central States Bridge Co., Indianapolis, and Mr. Baily was consulting engineer for steel structures with offices at Chicago.

Industrial Notes

Mr. Harry E. Dennie, who has been Pacific Coast manager for the Imperial Belting Co. of Chicago, has returned to Chicago to assume the general managership of the company. Mr. W. S. Bloomer becomes sales manager.

The Mackinaw Sand & Gravel Co., operating plants at Chillicothe and Mackinaw, Ill., announces a change of name to the McGrath Sand & Gravel Co., and increase of capital stock from $25,000 to $100,000. The new plants will be built at Pekin and Forreston, Ill.

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Volume XLVIII. CHICAGO, ILL., AUGUST 29, 1917. Number 9.

Are High Wages Here to Stay?

Common laborers are receiving as high as $3.50 a day, and occasionally more if they are exceptionally strong and willing. In California, for example, some common laborers working in concrete mixing gangs are receiving 50 ct. an hour. Probably the average daily wage of unskilled workers in America exceeds $2.50 a day.

Since the cost of labor forms a large part of the total cost of nearly every kind of civil engineering construction, it is a matter of importance to many of our readers to forecast correctly the trend of wage rates. If civil engineers were convinced that wages would recede greatly after the war, they would recommend the curtailment of construction work during the war. Some engineers have, in fact, advised such curtailment. But what basis of fact is there for belief that wages will go down? Is it reasoned that the sudden and marked rise in wages must be followed by a fall? Where are the data of past wage fluctuations that justify such an inference?

Wages, it should be remembered, are more stable than the prices of materials and vastly more resistent to a depressive force. Whether wages rise through the organized effort of labor union or because of increased demand for labor, there is the same determination on the part of workmen to hold every gain that is made. Nothing short of very hard times has yet served to weaken this determination. Since the panic of '93 there has not been a single general downward move in wage rates in America. The trend has been steadily upward, finally culminating in the very rapid rise that has occurred in the past three years of war.

In the final analysis the average rate of wages in any country is based on the average productiveness of the workers, high wages invariably accompanying high productivity. The present war has increased average productivity. We are not now speaking of the productivity of any particular class of men, such, for example, as the laborer employed on civil engineering works. We refer to the productivity of the entire nation of workers in mills, mines, fields and wherever human energy is applied. The present year will show the greatest per capita productivity in our history as a nation. Yet we have barely begun to learn the use of power, machinery and efficient methods. The war has merely stimulated us to think and to act. Note, for example, the striking increase in the ton-miles of freight per car during the last year. The very railroad presidents who called Brandeis a visionary crank a few years ago, when he said that the railways could save a million dollars a day by scientific management, are already pointing with justifiable pride to an increase of 14 per cent in freight car efficiency effected since the war-begotten congestion of traffic roused them to action. It is not too much to expect that American railway efficiency will increase 25 per cent in consequence of the intensive study of transportation problems that this war has brought about.

Even prior to the war we in America had been speeding up our output in nearly all industrial lines. Scientific management, first a part of the vocabulary of engineers only, had already become an expression familiar to all men, and its tenets were expounded in the columns of the daily papers. The theory that labor is more efficient when paid either higher wages or a bonus for increased output had been thoroughly demonstrated. In short, wage rates were already rising rapidly, if somewhat spasmodically and in spots, before the war began. The war accelerated and broadened the rise. Nor can we see any reason for believing that the end of the war will end the upward sweep of wage rates.

If we fall back upon the old "law of supply and demand" as a guide in prognosticating wages, we find it pointing to a conclusion the same as that arrived at from consideration of the effect of increased productiveness of labor. The war, by crippling and killing millions of men, is reducing the supply of workmen. European governments are likely to restrict emigration after the war, in order to build up their own industries. Moreover, necessity will have taught them the greater use of machinery, which in turn will have permanently raised their wage levels also. So America can not look for a considerable influx of labor after the war.

To the question that heads this article the answer is, Yes.

Form of War Contracts.—As the result of conferences extending over two months, the government interdepartmental cost conference has made public its recommendations that where fair prices can be obtained, war contracts should be in the form of straight purchase-and-sale contracts at fixed prices, that the cost plus contract may be necessary where the production involves difficult and complicated manufacturing effort or conditions which can not be clearly foreseen, and that in cost-plus contracts a fixed profit of a definite sum of money per article be agreed upon as far as possible, instead of the percentage of cost.

What One Engineering College Is Doing to Recruit Its Classes

To the Editor: The writer was very interested in an article which appeared in your issue of June 25, entitled "What are the Engineering Colleges doing to recruit their Classes?" About a month prior to this, the Engineering division of the Oregon Agricultural College sent the enclosed letter to every high school junior and senior in the State of Oregon.

Your article is unquestionably pertinent and timely; however, the writer felt that you should know that some of the colleges are thinking along the same line.

C. B. W. McCULLOUGH,
Prof. of Civil Engineering.
Corvallis, Ore.

(The letter referred to in Prof. McCullough's communication follows in part.—Editor.)

Do you want to enter training for patriotic service of a far higher type than that of which you are at present capable, and at the same time enter a profession which now, as never before, offers magnificent opportunities?

Then carefully read and consider the following facts:

That the demand for trained engineers to meet the growing industrial need is far greater than the supply.

That Europe is calling for 10,000 trained American engineers to meet the present military situation and will no doubt need many times this number.

That not only during the present war but during the long period of reconstruction following it, engineers and engineering talent will be in greater demand than ever before in the history of nations—that upon American engineers will in large measure devolve the task of rebuilding devastated Europe.

That so great is the need for American engineering talent in Europe that the greatest universities there are offering, as inducement to American engineering graduates, $1,000 scholarships for further study and research.

That at the Oregon Agricultural College, alone, the demand, this spring for graduates to fill engineering positions exceeded the available supply by 200 to 300 per cent.

That our own government, realizing the great military and industrial value of men trained along engineering lines has recently issued through the United States Department of the Interior the following statement:

"We therefore believe, first, that all young men below the age of liability to the selective draft and those not recommended for special service, who can avail themselves of the opportunities offered by our colleges, should be urged so to do in order that they may be able to render the most effective service, both during the full period of the war and in the trying times which will follow its close.

"We believe, third, that in view of the supreme importance of applied science in the present war, students pursuing technical courses, such as medicine, agriculture and engineering are rendering, or are to render, through the continuance of their training, service more valuable and efficient than if they were to enroll in military or naval service at once."

These facts may appear more pertinent to your experience by referring specifically to certain industries that are responding to the new demands.

The unprecedented growth of our shipbuilding industry, for instance, creates a demand for Mechanical, Chemical, Electrical and Civil engineers greater than ever before. The extent of the present movement for better highways may be appreciated from the fact that no less than twelve states have this year organized new state highway departments and have commenced a comprehensive program of road building. This means a greatly increased demand during the coming years for highway engineers.

Our nation's industrial activities are now thrown entirely on their own resources. Without the aid we have received heretofore from scientific Europe, the nation is now forced to look to her own engineers for the solution of her manifold industrial problems. Cost reduction methods, efficiency engineering, scientific investigation and research, these are the activities which are creating a demand for the service of the engineer.

The field of munitions manufacture, the conversion of our water-power resources into electrical energy, the reclamation of our lands for agricultural purposes, the electrification of our railway facilities, the sanitation of our newly established industrial sites, these are but few of the many opportunities for engineering activity in civil life.

From the military side the Electrical and Mechanical engineer finds an outlet in the signal corps, the aviation corps or the ordnance department of the army and navy; the Chemical and Mining engineer in the manufacture and handling of explosives and the Civil engineer in the building of military roads and bridges, military railways, fortifications, wharves, docks, etc., as well as in the work of military surveying and mapping.

So much for the general opportunities. How about the salaries? You have a perfect right to know, for although financial returns are perhaps of secondary importance, they are important. As answering this query the American Society of Civil Engineers has recently made a careful investigation of salaries paid engineers and reported salaries ranging from $600 to $150,000 a year with an average of $4,032. This investigation includes 6,378 engineers. In commenting upon the figures, the society committee states that, "the compensation for engineering work compares favorably with that received by men of any other profession."

As a specific illustration of engineering salaries, it may be noted that the government has recently advertised examinations for over forty engineering positions in the Civil Service at salaries ranging from $75 a month to $6,000 a year.

Increase in Cost of Street Railway Supplies and Equipment

In a hearing Aug. 7 before the upstate Public Service Commission of New York, Edmund P. Waller, manager of the Railway Department of the General Electric Co., and Roscoe Seybold, of the Westinghouse Electric and Manufacturing Co., testified that all kinds of electric apparatus used by street car companies, on account of increased costs of labor and materials, cost from 50 to 125 per cent more than in 1914. Labor costs in the production of these supplies had advanced from 30 to 40 per cent since 1914; steel plates had increased as much as 700 per cent, copper 120 per cent, steel castings 100 per cent, steel forgings 340 per cent, coal 80 per cent, brass 200 per cent.

W. G. Kaylor of the Westinghouse Traction & Brake Co. testified that since April, 1917, air brake equipment had increased 27 per cent in price, and James S. Thompson, vice-president of the American Brake Shoe & Foundry Co., testified to a 63 per cent increase in cost of brake shoes.

Wm. H. Englund of the Electric Service Supply Co. of Philadelphia testified that trolley wire, insulators, etc., had increased 200 per cent in the last three years, due to increased costs of labor and material, especially copper.

Prof. Roswell C. McCrea of Columbia University testified that labor costs had increased greatly in the last three years, and declared it practically a certainty that still more increases are near at hand.

A new law for railway concessions in Venezuela has been signed by the Provisional President. The principal difference between this law and the former one is that the provision by which all railways constructed under concessions became the property of the Government after a specified term of years is changed, and railways to be built under the new law will be fully and perpetually the property of the parties constructing them except that such ownership may not be transferred in whole or in part to any foreign government. It is hoped that under the morel liberal terms of this new law foreign capital may undertake the construction of railways which the country so badly needs for its internal development.

Price Changes for Common Labor and Construction Material During the Past Year

Prevailing Local Figures on August 1, 1916, and August 1, 1917, in Various Cities Throughout the Country

City.	Common labor. 8-hour day. 1916.	1917.	2-horse team and driver. 8-hour day. 1916.	1917.	Cement, f. o. b. City. Per Bbl. 1916.	1917.	Sand, f. o. b. City. Per Cu. Yd 1916.	1917.	Broken Stone, f. o. b. City. Per Cu. Yd. 1916.	1917.	Gravel, f. o. b. City. Per Cu. Yd. 1916.	1917.
Bangor, Me.	$2.25[1]	$2.50[1]	$5.00[1]	$6.00[1]	$2.10	$2.65	$1.00	$1.30	$2.50	$3.00	$1.15	$1.30
Lewiston, Me.	2.00[1]	2.50[2]	....	....	.47[3]	.62[3]	....	....	....	....	....	....
Portland, Me	2.50	3.25	5.00	7.00	2.00	2.50	.25	.35	1.62	1.82	.25	.35
Concord, N. H	2.25[1]	2.50[1]	5.00	6.00	1.75	2.75	1.00	1.25	....	....	....	....
Manchester, N. H.	.26½*	.30*	.67*	.67*	1.95	2.32	.40†	.65†	1.00†[4]	1.14†[4]	.75†	1.00†
Cambridge, Mass.	....	2.75	....	....	..	1.82	....	1.15	....	2.10	....	1.52
Fall River, Mass.	2.40	2.60	6.00	6.00	1.80	2.16	1.18	1.18	2.13	2.20	....	....
Fitchburg, Mass.	.30*[5]	.38*[5]	5.50	6.50	2.00	2.30	....	...	....	....	....	....
Haverhill, Mass.	2.33	2.75	5.00	6.00	1.91	2.34	1.50	1.50	1.15	1.25	1.50	1.50
Worcester, Mass.	2.00	2.40	5.00	6.00	2.15	2.96	1.50	1.75	1.50	1.75	.50	.50
Bridgeport, Conn.	2.25	3.00	6.00	7.00	2.20[6]	2.80[7]	1.50	1.60	1.27[7]	1.90†	1.60	1.75
Albany, N. Y.	2.52[1]	3.00[1]	6.00[1]	7.00[1]	1.35	1.75	.30[8]	.40[8]	1.30	1.60	....	....
Gloversville, N. Y.	2.25	2.50	5.00	5.60	1.00	2.40	1.00	1.25	...	....	1.00	1.25
Rochester, N. Y.	2.16	2.56	5.50	6.00	1.91	2.34	.72†	.92†	1.12†	1.27†	.92†	1.12†
East Orange, N. J.	2.50	2.75	6.00	7.00	[illegible]	1.65[10]	.85	1.00	1.25	2.00	....	....
Baltimore, Md.	2.00	2.25	5.00	5.50	1.76	1.93	.45	.55	2.20	2.35	.75	.90
Durham, N. C.	1.40[11]	1.75[11]	4.00[11]	5.00[11]	1.70	3.00	1.00	1.00	2.10	2.35	....	....
Greensboro, N. C.	1.25	1.75	3.50	5.00	2.27	2.67	.90	1.00	1.75	2.25	....	....
Atlanta, Ga.	1.50[1]	1.80[1]	3.75[1]	4.00[1]	1.25	1.75	.60	.75	1.75	2.22	....	....
Macon, Ga.	.12½*	.15*[12]	.40*	.55*	1.73	2.30	.60	.75	1.30†	1.30†	1.50	1.50
Mobile, Ala.	1.50	2.00[13]	4.00	4.50	[illegible]	2.53[14]	1.25	1.00	...	....	1.75	2.00
Montgomery, Ala.	1.00	1.50	4.00	5.00	.	....	1.25	1.25	....	....	2.00	2.75
Paducah, Ky.	1.20	1.60	2.80	4.00	1.60	2.20	.60	.75	.90†	1.10†	.70	.85
Fort Smith, Ark.	1.50[11]	2.00[11]	3.50[11]	4.00[11]	.	...	.80	1.00	1.25	1.50	1.00	1.50
Hattiesburg, Miss.	1.10[11]	1.50[11]	4.00[11]	5.00[11]	2.60	3.10[15]	1.00	1.20	...	....	1.25	1.50
Vicksburg, Miss.	1.50[16]	2.00	4.00	5.00	1.89	2.75	.90	1.25	4.00	6.00	1.25	1.60
Columbus, O.	2.00	2.40	5.00	5.60	1.70	2.40	.85[17]	1.00[17]	.85[17]	1.00[17]	.85[17]	1.00[17]
Dayton, O.	2.75	3.00	4.80	6.00	[illegible]	2.17[10]	1.25	1.50	1.25	1.50	1.25	1.50
East Liverpool, O.	.27½*	.30*	5.00	7.00	2.10	2.40	.60†	.75†	....	....	.60†	.75†
Joliet, Ill.	.35*	.40*[20]	6.50	....	1.80	2.30	1.50	1.75	.60	.75	....	....
Oak Park, Ill.	3.00	3.00	7.00	7.00	2.21	2.71	.85	1.40	.85	1.40	.85	1.40
Peoria, Ill.	2.00	2.80[23]	5.00	7.00	1.45	2.15	1.20	1.55	...	....	1.30	1.05
Quincy, Ill.	2.25	3.00	5.00	6.50	1.88	2.38	.50	.50	1.10	1.25	.85	1.10
Fort Wayne, Ind.	2.20	2.40	4.80	4.80	1.24	1.99	1.25	1.32	1.52	1.57	1.45	1.55
Richmond, Ind.	.20*	.25*	.40*	.45*	2.00	3.00	1.50	1.50	1.00	1.15	1.15	1.15
Terre Haute, Ind.	1.75	2.25	4.00	5.00	1.60	2.25	1.00	1.25	....	....	.75	1.00
Ann Arbor, Mich.	2.40	2.80	4.00	4.80	1.50	2.40	.75	.85	...	....	1.00	1.30
Kalamazoo, Mich.	2.24	2.80	4.50	5.20	1.81	2.36[24]	....	....	....	....	.70	.80
Minneapolis, Minn.	2.50	2.80	5.00	6.00	1.47	1.82	1.00	1.00	1.00	1.00	1.00	1.00
Red Wing, Minn.	2.25[27]	2.62[1]	4.50[27]	5.50[27]	2.10	2.33	....	1.48	....	2.17	....	1.80
St. Paul, Minn.	.25*	.30*	.60*	.66*	1.85	2.18	1.00	1.00	1.70	1.80	1.70	1.80
Burlington, Ia.	1.78	2.40	3.60	4.80	1.90	2.40	.38	.38	1.10	1.40	.90	1.00
Wichita, Kan.	1.75	2.50	3.50	5.00	1.72	3.02	.15	25	1.35†	1.55†	....	....
Grand Island, Neb.	2.00	2.40	4.00	5.00	1.96	2.56	1.00	1.00	....	....	1.00	1.00
Hannibal, Mo.	1.60	2.00	3.20	4.00	1.80	2.40	.90	1.00	.62	.75	.90	2.40
Kansas City, Mo.	2.00[32]	2.50[33]	5.00	6.00	1.50	2.35	.90	.90	1.10	1.40	....	....
St. Joseph, Mo.	.20*	.25*	.45*	.60*	1.10	2.30	1.10	1.35	1.45	1.62	....	....
St. Louis, Mo.	2.00	3.00	4.50	6.00	1.25	2.65	.85	1.25	.45	.60	1.25	1.75
Austin, Tex.	1.75	1.75	3.50	3.50	2.20	2.40	.60	.60	....	....	....	....
Beaumont, Tex.	1.75	1.92	....	....	1.55	2.25	.50	.50	....	....	1.85	2.25
Galveston, Tex.	2.00	2.40	4.40	5.00	.	....	.90	.90	....	....	2.15	2.50
Colorado Springs, Colo.	2.25[28]	2.75[29]	5.00	6.00	1.90	2.60	.85	1.00	2.00	2.00	.85	1.00
Denver, Colo.	2.50	3.00	5.00	6.00	2.17	2.39	1.00	1.50	1.70	1.83	1.25	1.50
Pocatello, Idaho	2.50[30]	3.00[31]	6.00	7.00	2.62	3.00	1.00	1.25	1.50	1.75	.90	1.10
Great Falls, Mont.	3.00	3.75	6.00	8.00	2.27	2.57	1.00	2.00	....	....	1.75	2.25
Logan, Utah	2.25	2.80	4.00	5.00	2.52	2.62	.90	1.00	.90	1.00	.90	1.00
Ogden Utah	2.50	3.00	4.50	6.00	2.00	2.37	1.00	1.50	1.00	1.50	1.00	1.50
Provo, Utah	2.00	2.75	4.00	5.50	2.27	2.74	.70	1.00	....	....	.70	1.00
Alameda, Cal.	3.00	3.00	5.50	5.50	2.55	2.55	1.75	1.75	1.75	1.50	1.75	1.75
Berkeley, Cal.	2.50	2.75	5.20	5.20	2.50	2.55	1.50	1.67	1.60	1.60	1.58	1.65
Los Angeles, Cal.	2.50	2.50	5.00	5.00	1.93	2.18	.65†	.71†	1.20†	1.20†	....	....
Eugene, Ore.	2.25	3.00	4.50	6.50	2.70	3.10	1.50	1.50	1.00	1.00	1.00	1.00
Portland, Ore.	2.75	3.00	5.00	6.50	2.30	2.25	.94	.92	.50	.44	.50	.44
Everett, Wash.	2.65	3.25	6.00	7.00	2.10[10]	2.65[10]	1.40	1.40	....	....	1.40	1.40
Seattle, Wash.	2.75	3.25	6.50	8.00	2.30	2.80	.75	.75	1.00	1.00	.75	.75
Tacoma, Wash.	2.50	3.00	5.50	7.50	1.90	2.30	1.00	1.50	1.75	2.25	1.00	1.50

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*Per hour. †Per ton.

[1] 9-hour day. [2] $2.25 to $2.50. [3] Net per bag. [4] $1.00-$1.30; $1.14 to $1.75. [5] 28 to 30 ct.; 34 to 38 ct. [6] Car load $1.86. [7] Car load $2.21. [8] At bank. [9] Base price. [10] Net. [11] 10-hour day; $1.75 to $1.90. [12] 15 ct. and 20 ct. [13] Striking for $2.50. [14] Gross. [15] In small amounts. [16] $1.35 to $1.50. [17] At plant. [20] 40 to 45 ct. [21] $80 to $94. [22] $90 to $100. [23] $2.80 to $3. [24] In cloth sacks. [26] Contract price for year. [27] 10 hours. [28] $2.25-$2.50. [29] $2.75-$3.00. [30] $2.50-$2.75. [31] $3.00 to $3.50. [32] $2 to [illegible] $2.50 to $3.

Prices of Cast Iron Pipe During the Past 50 Years

Interesting statistics on the price of cast iron pipe were presented by Mr. Burt B. Hodgman, Chief Engineer of the National Water Main Cleaning Co., in a paper presented at the last annual meeting of the American Water Works Association. In his paper, an abstract of which is given below, Mr. Hodgman gives the prices actually paid for cast iron pipe by the city of Boston, Mass., during the past 50 years.

It is interesting to note that the present prices are not as high as the maximum prices paid during the period covered. In 1868 Boston paid $78 per long ton for 6-in. pipe. In 1873 the price was $67 per long ton; in 1897 the price was $16.20 per short ton, and in 1917 it was $45 per short ton.

In 1832 Richmond, Va., purchased 10-in. pipe from Samuel & Thomas S. Richards of Philadelphia for $1.38 per foot, the pipe being in 9-ft. lengths and 9/16 in. in thickness. This amounts to about $54 per ton of 2,000 lb., and the price was for pipe delivered at Richmond. The cost in 1832 of other sizes of pipe was as follows:

	Per foot.
8-in. pipe was	$1.25
6-in. pipe was	.70
4-in. pipe was	.45
3-in. pipe was	.37
In 1844 3-in. pipe was bought for	.30

In 1854 16-in. and 8-in. pipe was purchased in Richmond from R. & S. H. Jones at $52.50 per long ton. The pipe was cast at Florence, N. J. In 1832 10-in. valves were purchased in Richmond at $70, 8-in. valves at $56, 6-in. valves at $44.50, 4-in. valves at $30 and 3-in. valves at $28.

PRICES OF CAST IRON PIPE AND SPECIALS.

Elgin, Ill.

Year.	Pipe.	Specials.
1887	$34.70	$55.00
1888	34.70	55.00
1889	24.70	45.00
1890	28.00	50.00
1891	27.40	42.50
1892	27.00	42.75
1893	26.50	42.50
1894	24.70	41.50
1895	24.70	41.50
1896	28.00	50.00
1897	28.00	48.50
1898	23.85	45.00
1899	23.50	43.50
1902	24.00	45.25
1905	30.00	50.00
1906	27.00	46.50
1907	21.40	41.40
1908	21.00	42.50
1909	23.00	45.00
1910	22.50	45.00
1911	23.00	44.75
1912	23.45	45.00
1913	23.50	45.00
1914	23.70	45.25

Rochester, N. Y.

Year.	Pipe.	Specials
1884	$30.00	$45.00
1885	27.90	60.00
1887	34.00	60.00
1890	24.50	46.00
1891	23.20	46.00
1892	21.20	45.00
1894	18.68	45.00
1895	18.90	40.00
1896	18.25	40.00
1897	16.70	38.00
1898	15.27	35.00
1899	22.00	50.00
1900	25.25	45.00
1901	20.80	45.00
1902	26.75	60.00
1903	32.50	70.00
1904	22.80	50.00
1905	25.40	50.00
1906	26.80	55.00
1907	23.20	60.00
1908	24.30	50.00
1909	22.70	50.00
1910	24.00	50.00
1911	20.70	49.00
1912	21.20	48.00
1913	24.25	50.00
1914	21.95	

Portland, Ore.

(All prices per ton of 2,000 lbs.)

Year.	Size.	Pipe.	Specials.
1908	16″	$42.75	......
1910	4″	37.00	......
....	12″	37.00	$60.00
1911	10″	32.35	......
....	20″	32.35	48.00
....	10″	30.90	......
....	20″	30.50	......
1913	6″	34.25	......
....	8″	34.50	......
....	24″	34.00	......
....	30″	34.00	52.00
1914	6″	30.20	......
....	8″	30.20	......
....	12″	30.20	......
....	16″	30.20	......
....	24″	30.20	......
....	30″	30.20	......

Lowell, Mass.

(1870 to 1902, 2,240 lb. to ton; 1904 to 1914 2,000 lb. to ton.)

Year.	Pipe.	
1870	$63.00	$0.04 per lb.
1873	73.00	$0.04 per lb.
1874	42.00	$0.04 per lb.
1876	36.39	
1880	51.00	$70 per ton
1882	45.00	$0.03 per lb.
1884	55.00	
1889	23.31	
1895	23.85	
1895	19.70	
1897	18.18	
1899	21.75	
1899	23.00	
1902	28.20	
1904	23.20	$0.05 per lb.
1905	29.20	
1906	32.70	
1909	25.20	
1909	24.20	
1910	22.30	
1910	22.00	
1911	21.45	
1912	22.34	
1913	22.23	
1914	22.49	
1914	21.95	

CAST IRON PIPE COSTS AT BOSTON, MASS.

(Long tons from 1868 to 1896; short tons from 1896 to 1917, inclusive.)

Year.	Tonnage.	Size.	Price paid.	From whom purchased.
1868	446	6″	$ 78.40	R. D. Wood & Co.
	446	12″	76.16	
	312	24″	74.67	
	2,232	48″	75.94	
	45	*	112.00	
1868	45	4″	71.00	S. Fulton & Co.
	547	6″	71.00	
	600	12″	71.00	
	230	16″	71.00	
1870	75	4″	52.00	
	625	6″	52.00	
	670	12″	52.00	
	70	16″	52.00	
1870	700	6″	53.00	J. W. Starr
	1,700	12″	53.00	
	700	20″	53.00	
	470	24″	53.00	
1871	959	6″	57.50	J. W. Starr
	1,541	12″	57.50	
1873	950	6″	67.20	Gloucester Iron Works
	190	8″	67.20	
	475	12″	63.30	
	750	12″	60.00	
	250	16″	60.00	
	85	*	109.20	
1874	600	8″	51.00	R. D. Wood & Co.
	1,255	12″	51.00	
	385	16″	51.00	
	955	20″	51.19	
	771	24″	52.00	
	160	*	86.80	
1874	900	8″	45.00	J. W. Starr
	960	12″	45.00	
	200	*	72.80	
1875	880	6″	42.00	J. W. Starr
	740	8″	42.00	
	2,340	12″	42.00	
	1,104	16″	42.00	
	300	40″	46.00	
	260	*	89.60	
1876	300	6″	35.00	J. W. Starr
	530	8″	35.00	
	2,180	12″	35.00	
	45	*	56.00	
1877	75	4″	30.00	J. W. Starr
	385	6″	30.00	
	540	12″	30.00	
	1,200	48″	27.00	
	910	12″	.....	?
	2,200	48″	30.00	?
	140	*	67.20	?
1878	470	6″	26.77	Warren Fdry. & Mach. Wks.
	180	8″	26.47	
	910	12″	26.47	
	60	16″	26.47	
	480	30″	25.92	
	50	*	43.65	
1879	235	6″	25.20	McNeal Pipe & Fdry. Co.
	225	8″	25.15	
	25	*	42.00	
1880	600	6″	42.00	J. W. Starr
	220	10″	33.15	
	475	12″	42.00	
	20	*	56.00	(small sizes)
1880	4,700	48″	40.95	Warren Fdry. & Mach. Co
	100	*	80.00	R. D. Wood & Co.
1881	20	4″	31.90	McNeal Pipe & Fdry. Co.
	310	6″	31.90	
	140	8″	31.90	
	625	12″	31.90	
	50	16″	31.90	
	25	30″	31.90	
	60	*	61.50	
1882	15	4″	39.00	Camden Iron Works
	415	6″	39.00	
	440	12″	39.00	
	370	16″	39.00	
	80	*	59.00	
1883	30	4″	36.80	R. D. Wood & Co.
	300	6″	36.80	
	370	8″	36.80	
	600	12″	36.80	
	60	16″	36.80	
	420	24″	36.50	McNeal Pipe & Fdry. Co.
	90	30″	36.50	
	80	*	36.80	R. D. Wood & Co.
1883	550	48″	36.00	R. D. Wood & Co.
	150	*	70.00	
1884	20	4″	34.75	Donaldson & Thomas
	500	6″	34.75	
	210	8″	34.75	
	750	12″	34.75	
	50	16″	26.45	
	150	*	58.80	
1885	20	4″	29.19	McNeal Pipe & Fdry. Co.
	520	6″	29.19	
	425	8″	29.19	
	865	12″	29.19	
	120	16″	29.19	
	900	24″	26.46	
	1,920	30″	26.45	
	100	*	53.20	
1886	25	4″	29.40	R. D. Wood & Co.
	650	6″	29.40	
	270	8″	29.40	
	370	10″	29.40	
	700	12″	29.40	
	70	*	29.19	
1887	30	4″	33.90	Gloucester Iron Works
	600	6″	33.09	
	200	8″	33.09	
	180	10″	33.09	
	1,320	12″	32.71	
	100	*	29.40	

Year.	Tonnage.	Size.	Price paid.	From whom purchased.
1887	35	36″	33.75	R. D. Wood & Co.
	40	48″	33.75	
	150	*	56.00	
1887	480	16″	30.69	Gloucester Iron Works
	800	30″	30.69	
	100	*	61.60	
	1,100	24″	35.00	Camden Iron Works
	170	30″	34.50	
	450	48″	34.00	
	80	*	74.00	
1888	1,000	6″	26.45	McNeal Pipe & Fdry. Co.
	550	8″	28.45	
	1,400	12″	28.45	
	150	*	57.00	
	440	6″	28.91	Gloucester Iron Works
1889	35	4″	28.43	Gloucester Iron Works.
	750	6″	28.31	
	350	8″	28.31	
	300	12″	27.55	
	530	16″	27.55	
	1,450	20″	27.40	
	25	*	53.20	
1890	30	4″	30.34	R. D. Wood & Co.
	700	6″	30.34	
	450	8″	30.34	
	100	10″	30.34	
	600	12″	30.34	
	900	24″	30.34	
	150	*	30.34	
1890	100	6″	31.40	R. D. Wood & Co.
	350	8″	31.40	
	300	10″	31.40	
	650	12″	31.40	
	100	*	31.40	
1891	30	4″	27.95	R. D. Wood & Co.
	750	6″	27.95	
	1,300	12″	27.95	
	200	24″	27.95	
	1,100	30″	27.95	
	150	48″	27.95	
	150	*	27.95	
1891	350	12″	27.25	Gloucester Iron Works
1892	20	4″	25.40	Radford Pipe & Iron Co.
	600	6″	25.40	
	600	8″	25.40	
	100	10″	25.40	
	1,300	12″	25.40	
	300	16″	25.40	
	150	*	50.40	
1893	10	4″	25.94	R. D. Wood & Co
	600	6″	25.94	
	400	8″	25.94	
	100	16″	25.94	
	390	24″	25.21	
	1,100	36″	25.21	
	150	*	25.60	
1894	...	4″	22.45	?
	...	6″	22.45	
	...	8″	22.45	
	...	10″	22.45	
	...	12″	22.45	
	...	16″	22.45	
	...	20″	22.45	
	...	24″	22.45	
	...	30″	22.45	
	...	*	22.45	
1895	67	10.	20.90	Warren Fdry. & Machine Co.
	887	12″	20.90	
	673	36″	20.90	
	2,232	42″	20.90	
	1,188	48″	20.90	
	180	*	42.00	
1895	57	10″	23.60	McNeal Pipe & Fdry. Co.
	218	12″	23.60	
1895	22	4″	21.60	R. D. Wood & Co.
	280	6″	21.60	
	798	8″	21.60	
	680	36″	21.60	
	2,264	42″	21.60	
	1,394	48″	21.60	
	205	*	21.60	
1895	169	36″	23.80	R. D. Wood & Co.
1896	100	30″	23.90	McNeal Pipe & Fdry. Co.
	46	40″	22.90	
	60	*	50.40	
1896	1,600	12″	19.80	R. D. Wood & Co.
	793	16″	19.80	
	683	20″	19.80	
	56	*	19.80	
1896	20	4″	20.25	R. D. Wood & Co.
	951	6″	20.25	
	473	6″	20.25	
	204	10″	20.25	
	602	16″	19.80	
	13	20″	19.80	
	200	24″	19.80	
1896	150	30″	22.45	McNeal Pipe & Fdry. Co.
	18	40″	22.25	
1896	19	*	50.40	McNeal Pipe & Fdry. Co.
1897	30	4″	19.40	Warren Fdry. & Mach. Co.
	395	12″	18.40	
1897	63	36″	18.60	R. D. Wood & Co.
	11	*	62.50	
1897	278	8″	17.38	Camden Iron Works
	51	10″	17.38	
	800	12″	17.38	
	229	16″	17.38	
	588	24″	17.38	
	497	30″	17.38	
	624	36″	17.38	
	52	*	17.38	
1897	703	6″	17.17	McNeal Pipe & Fdry. Co.
	555	12″	17.17	
	621	20″	17.17	
	507	30″	17.17	
	632	36″	17.17	
1897	90	*	37.00	R. D. Wood & Co.

Year.	Tonnage.	Size.	Price paid.	From whom purchased.
1897	15	4″	16.03	McNeal Pipe & Fdry. Co.
	200	6″	16.03	
	150	8″	16.03	
	102	10″	16.03	
	543	12″	16.03	
1898	19	4″	16.75	Warren Fdry. & Mach. Co.
	764	6″	16.75	
	506	8″	16.75	
	232	10″	16.75	
	1,380	12″	16.75	
	841	16″	16.75	
	926	20″	16.70	
	647	24″	16.75	
	279	36″	16.75	
	73	*	33.00	
1898	713	12″	17.60	Warren Fdry. & Mach. Co.
	322	16″	17.00	
1899	20	4″	16.70	Warren Fdry. & Mach. Co.
	654	6″	16.70	
	880	8″	16.70	
	51	10″	16.70	
	2,455	12″	16.70	
	601	16″	16.70	
	232	24″	16.70	
	410	30″	16.70	
	11	*	33.00	
1900	14	4″	26.00	Warren Fdry. & Mach. Co.
	609	6″	26.00	
	507	8″	26.00	
	150	10″	26.00	
	1,000	12″	26.00	
	502	16″	26.00	
	208	30″	26.00	
	17	*	44.00	
1900	88	8″	20.90	U. S. C. I. Pipe & Fdry. Co.
	96	10″	20.90	
	344	12″	20.90	
	395	16″	20.90	
1901	15	4″	20.40	U. S. C. I. Pipe & Fdry. Co.
	296	6″	20.40	
	788	8″	20.40	
	480	10″	20.40	
	1,643	12″	20.40	
	1,025	16″	20.40	
	870	30″	20.40	
	27	36″	20.40	
	10	*	20.40	
1902	10	4″	26.45	U. S. C. I. Pipe & Fdry. Co.
	302	8″	26.45	
	304	10″	26.45	
	503	12″	26.45	
	88	30″	26.45	
	585	36″	26.45	
	558	40″	26.45	
	17	*	49.00	
1903	21	4″	[illegible]	U. S. C. I. Pipe & Fdry. Co.
	150	6″	29.70	
	507	8″	29.70	
	346	10″	29.70	
	1,233	12″	29.70	
	454	16″	29.70	
	166	36″	29.70	
1903	245	10″	27.40	Camden Iron Works
	275	12″	27.40	
	358	30″	27.40	
	298	36″	27.40	
	15	*	54.00	
1904	10	4″	22.30	U. S. C. I. Pipe & Fdry. Co.
	504	8″	22.30	
	907	12″	22.30	
	127	16″	22.30	
	93	24″	22.30	
	136	48″	22.30	
	153	*	50.00	
1904	10	4″	26.99	U. S. C. I. Pipe & Fdry. Co.
	7	*	55.00	
1905	30	4″	27.20	U. S. C. I. Pipe & Fdry. Co.
	51	6″	26.20	
	176	8″	26.20	
	288	10″	25.20	
	814	12″	25.20	
	139	16″	25.20	
	152	24″	24.70	
	318	30″	24.70	
	55	*	52.50	
1906	7	4″	30.70	U. S. C. I. Pipe & Fdry. Co.
	71	6″	30.70	
	446	8″	30.70	
	304	10″	29.70	
	1,088	12″	29.70	
	355	16″	29.70	
	95	30″	28.70	
	148	36″	28.70	
	1,602	48″	28.70	
	92	*	57.50	
1907	[illegible]	4″	37.00	U. S. C. I. Pipe & Fdry. Co.
	76	6″	35.00	
	304	8″	35.00	
	198	10″	34.00	
	547	12″	34.00	
	50	16″	34.00	
	30	*	60.00	
1908	5	4″	24.50	Warren Fdry. & Mach. Co.
	122	8″	24.50	
	428	12″	24.25	
	204	16″	24.25	
	14	*	50.00	
1909	6	4″	23.30	Florence Iron Works.
	72	6″	23.30	
	450	8″	23.30	
	168	10″	23.30	
	828	12″	23.30	
	116	24″	23.00	
	1,222	30″	23.60	
	32	*	50.00	
1910	10	4″	24.60	
	60	6″	24.60	

Year.	Tonnage.	Size.	Price paid.	From whom purchased.
	[illegible]	8″	24.60	
	[illegible]	10″	24.60	
	147	16″	24.60	
	20	*	50.00	
1910	52	24″	21.89	Florence Iron Works
	523	30″	21.89	
	25	*	46.75	
1911	77	6″	20.70	U. S. C. I. Pipe & Fdry. Co.
	266	8″	20.70	
	[illegible]	10″	20.70	
	905	12″	20.70	
	672	16″	20.70	
	947	36″	20.70	
	33	*	47.00	
1912	32	4″	20.95	U. S. C. I. Pipe & Fdry. Co.
	79	6″	20.95	
	743	8″	20.95	
	844	10″	20.95	
	1,678	12″	20.95	
	299	16″	20.95	
	29	*	50.95	
1913	36	4″	23.60	U. S. C. I. Pipe & Fdry. Co.
	156	6″	23.60	
	610	8″	23.60	
	670	10″	23.60	
	895	12″	23.60	
	690	16″	23.60	
	80	30″	23.60	
	38	*	50.00	
1913	50	6″	20.85	U. S. C. I. Pipe & Fdry. Co.
	123	8″	20.85	
	604	10″	20.85	
	995	12″	20.85	
	1,006	16″	20.85	
	503	24″	20.85	
	2,408	30″	20.85	
	370	*	50.00	
1914	50	6″	21.10	Florence Iron Works
	800	8″	21.10	
	1,045	10″	21.10	
	1,543	12″	21.10	
	199	*	55.00	
1915	16	4″	21.15	Standard C. I. P. & Fdry. Co.
	49	6″	20.95	
	705	8″	19.99	
	1,189	10″	19.40	
	1,495	12″	19.40	
	99	16″	19.40	
	196	24″	19.40	
	303	30″	18.85	
	143	*	50.00	
1915	26	4″	27.92	Standard C. I. P. & Fdry. Co
	494	8″	23.87	
1916	52	4″	32.70	R. D. Wood & Co.
	120	6″	29.24	
	500	8″	29.24	
	700	10″	29.24	
	591	12″	29.24	
	341	30″	28.24	
	141	*	57.00	
1917	75	4″	48.50	
	100	6″	45.50	
	600	8″	45.50	
	700	10″	45.50	
	700	12″	44.50	
	200	16″	44.50	
	60	30″	44.50	
	40	40″	46.50	
	150	*	85.00	

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*Specials.

Cost of Electrical Supplies and Equipment

The July 6 issue of The Pretzel, a publication of the Reading Transit & Light Co. of Reading, Pa., contains some interesting notes on the prices paid by that company for materials, supplies and equipment.

Rails have increased 100 per cent over normal prices. Today they are quoted at $55 a ton for delivery a year hence and for short time delivery the price is $75 a ton. Two years ago steel rails were selling at $38.20, so that what is regarded as the normal price today is an advance of 44 per cent. There is an even greater advance in special track work which means curves, switches and the like, the increase in these materials being fully 200 per cent.

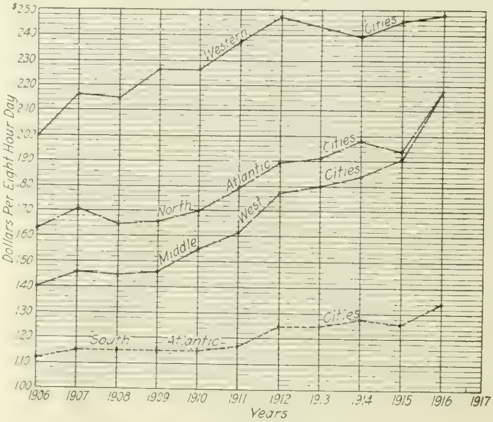
Copper has nearly trebled its normal price. Copper trolley wire is now quoted at 38 ct. a pound compared with 17 ct. in 1915. Copper feeder cable has advanced from 18 ct. to 34¼ ct. a pound in the same period. Motor equipment has advanced over 50 per cent. Some of the other advances follow:

	1915.	1917.
Track spikes	$2.15 per 100 lb.	$4.00 per 100 lb.
Steel trolley poles	$1.10 each	$2.10 each
Track plates	2½c lb.	10c lb.
Steel iron bars	1¾c lb.	4¾c lb.
Cotton waste	9c lb.	13c lb.
Chestnut ties	40c each	60c each
Cement	$1.29 bbl.	$2.09 bbl.
Gravel	1.25 ton	2.00 ton
Crushed stone	50c ton	1.00 ton

Trend of Wages of Common Labor from 1906 to 1917

The trend of wages of common labor, taking the country as a whole, has been steadily upward during the last decade. This fact is indicated in a general way by the accompanying diagram, which shows the average rate of pay during the period 1906-1916 inclusive, for common labor employed on paving work in various sections of the country. The figures on which the curves are based are the averages of the wage rates during the above period in 10 cities in each division. The rates were computed on the basis of an 8-hour day.

It will be noted that the lowest scale is paid in the Southern states, where negroes form the bulk of the labor. In this section wages were as low as 10 ct. to 12½ ct. an hour in 1906. The highest scale is paid in the Pacific Coast and Rocky Mountain States. Some of the cities in the mining regions were paying as much as $3 per 8-hour day for common labor as far back as 1909. In the Middle West cities the wage rates increased quite rapidly from 1910 to 1916, and in the latter year they reached the average for the North Atlantic cities.



Wage Curves on Basis of 8-Hour Day.

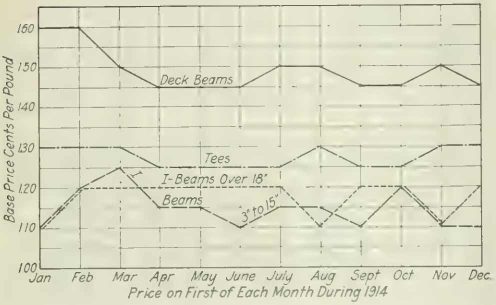
Not only has the rate of pay for common labor increased during the last decade, but the length of the working day has decreased until at the present time the 8-hour day is standard in many cities, at least for public work. In the South, however, 10 hours constitutes a working day in most localities, and in some New England States the 9-hour day is still quite common.

Wages of common labor rose rapidly in 1914, 1915 and 1916, but in 1917 there was an advance of 20 to 30 per cent over the 1916 figures.

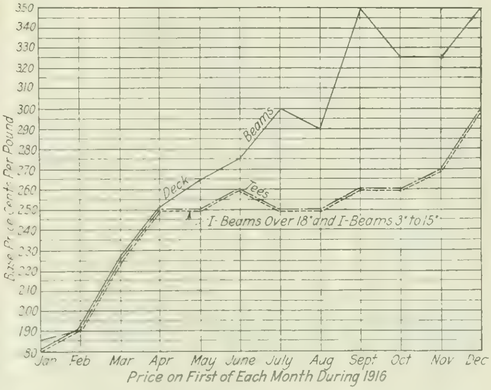
Making Better Use of Existing Freight Cars.—Reports just compiled by the Railroads' War Board indicate nation-wide co-operation on the part of shippers in the railroads' campaign to make better use of existing freight cars in order to be able the better to provide the increased amount of freight service which the necessities of the war have called for. It is estimated from these reports that during the month of July savings in space were effected by the shippers which increased the number of cars available for freight traffic by practically 120,000.

Trend of Structural Steel Prices During Past Four Years

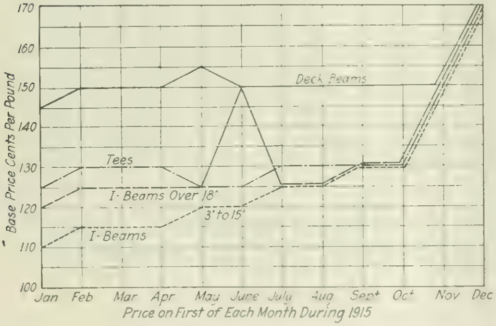
Curves Showing Cost of I-Beams, Tees and Deck Beams on First of Each Month in 1914-1917



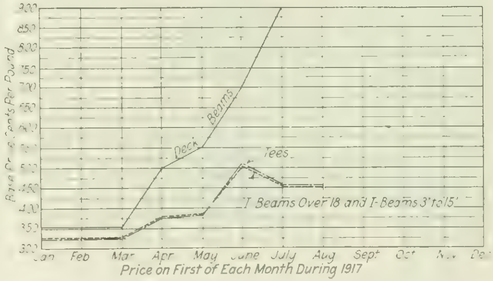
Base Price During 1914.



Base Price During 1916.



Base Price During 1915.



Base Price for 7 Months of 1917.

Prices for Railway Equipment, Materials and Supplies

The accompanying tabulation, reprinted from a recently issued circular of the Bureau of Railway News and Statistics, shows the prices paid in 1906 and in July, 1917, by one of the large western railways for equipment, materials and supplies.

PRICES PAID FOR RAILWAY EQUIPMENT, MATERIALS AND SUPPLIES IN 1907 AND JULY, 1917.

	1907.	1917.	Increase, per cent.
Equipment:			
Heavy freight locomotives, each	$16,243.75	$47,081.88	189.8
Passenger locomotives	16,057.10	33,142.59	106.4
Switching locomotives, each	11,857.71	20,052.62	69.1
Passenger coaches, each	7,330.00	9,506.00	29.7
Baggage cars, each	4,820.82	7,573.10	57.1
Box cars, each	815.67	1,104.09	35.4
Stock cars, each	758.47	1,316.37	73.6
Gondola cars, each	713.63	1,515.05	112.3
Ore cars, each	714.02	1,235.20	73.0
Track Material:			
Angle bars, No. 80, each	.317	.52	64.0
Track bolts, cwt	2.45	3.65	49.0
Track spikes, cwt	1.90	2.90	52.6
Spring rail frogs, Nos. 80 and 85, cwt.	39.00	62.72	60.8
High star switch stands, cwt	10.35	13.50	30.4
Low star switch stands, cwt	9.75	11.50	18.0
Rail braces, cwt	.12¼	.25½	108.2
Boat spikes, kegs	5.03	10.00	98.8
Ellis bumping posts, each	53.75	75.00	39.5
Hand car wheels, each	2.70	5.45	101.9
Maintenance of Equipment and Repairs:			
Air-brake repairs, discount	25% off	5% off	....
Journal boxes, 4¼x8 in., pass., each	2.20	2.85	29.6
Locomotive flues, foot	.16	.22	37.5
Pig copper, lb	.14	.32¾	134.0
Pig lead, lb	.07½	.11⅝	55.0
Pig tin, lb	.29½	.61½	108.5
Chain, 1 in., cwt	3.00	4.77	59.0
Common iron, cwt	1.72	2.79	62.2
Tank steel, cwt	1.75	5.19	196.6
Fire-box steel, cwt	2.90	10.50	262.1
Spring steel, cwt	2.35	4.25	80.9
Gray iron castings, N. T.	37.00	60.40	63.2
Malleable castings, cwt	3.00	7.00	133.3
Steel castings, cwt	7.78	10.75	38.2
Journal brasses, lb	.18	.27	50.0
Fire-brick, Queen run, M	30.00	65.00	116.6
Fire clay, bbl	1.50	1.75	16.6
Blacksmith coal, ton	3.15	5.00	58.7
Coke, ton	4.35	11.00	152.9
Crucibles, No. 80, each	3.80	12.80	236.8
Driving axles, cwt	2.90	10.70	269.0
Driving tires, cwt	3.00	4.75	58.3
Gas engine oil, gal	.20	.24	20.0
Wool waste, lb	.085	.16	88.2
1¼ in. W. I. gas pipe, foot	.0608	.142	133.6
Air-brake hose, 1⅜ in. x 22 in. each	.77	.92	19.5
Chamois skins, kip	9.50	22.35	135.3
Charcoal, ton	7.00	18.00	157.1
Station and Track Supplies:			
Railroad adzes, each	.58	.63	8.6
Claw bars, each	1.49	1.80	20.8
No. 2 track shovels, doz	6.50	9.90	52.3
Battery coppers, each	.08	.99	23.8
Brooms, doz.	2.10	4.65	121.9
No. 2 lamp burners, doz	.53	.75	41.5
Keystone seals (lead), M	7.50	12.00	60.0
No. 2 lamp chimneys, doz	.46	.84	82.6
Fuses, 10 minutes, gross	13.00	21.00	61.5
No. 2 claw hatchets, doz	4.00	7.15	78.7
Water pails, doz	4.25	6.90	62.4
Stove pipe, 7 in., per length	.11	.09	*18.2
Wheelbarrows, each	3.18	3.00	*5.6
Common wire nails, cwt.	2.00	3.95	97.5
15 in. monkey wrenches, each	.75	1.11	48.0
18 in. pipe wrenches, each	1.00	1.14	14.0
Wood armchairs, each	1.50	3.00	100.0
White lantern globes, doz	1.25	1.50	20.0

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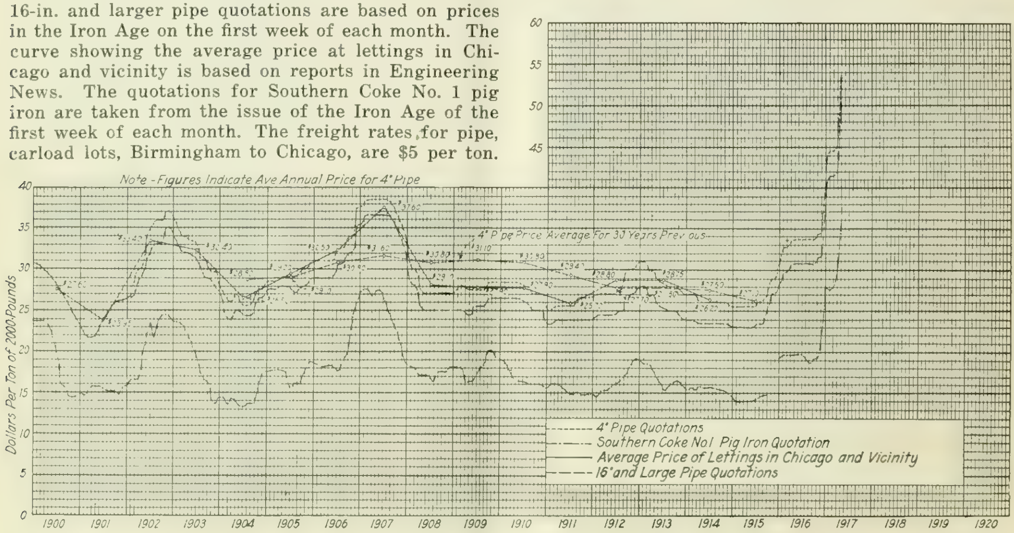
*Decrease.

Market Prices of Pig Iron and Cast Iron Pipe F. O. B. Chicago from 1900 to 1917

The accompanying diagram shows the ups and downs of cast iron pipe prices during the past 17 years. The diagram was prepared by Mr. John W. Alvord, Consulting Engineer, Chicago, from the average prices paid in Chicago and vicinity. As prepared by Mr. Alvord the curves covered the period 1885 to 1917, but owing to space limitations only that portion from 1900 on is reproduced here. The 4-in. and 16-in. and larger pipe quotations are based on prices in the Iron Age on the first week of each month. The curve showing the average price at lettings in Chicago and vicinity is based on reports in Engineering News. The quotations for Southern Coke No. 1 pig iron are taken from the issue of the Iron Age of the first week of each month. The freight rates for pipe, carload lots, Birmingham to Chicago, are $5 per ton.



Market Price of Pig Iron and Cast Iron Pipe, f. o. b. Chicago. from 1900 to 1917.

The figures in the diagram indicate the annual price for 4-in. pipe.

Cost Plus Percentage Contract of Bureau of Yards and Docks

The Bureau of Yards and Docks, U. S. Navy Department, has adopted recently a new form of contract involving payment on the basis of costs plus percentage. The percentage adopted is 10 per cent of the cost of that portion of the work performed by the principal contractor and 5 per cent of the cost of that portion of the work which may be performed under subcontracts, the latter being contracts entered into by the principal contractor which involve labor at the site of the work. This form of contract will be used only when the emergency is such that it is impossible, either on account of lack of time or for other reasons, to prepare plans and specifications in sufficient detail to permit the taking of formal bids in the usual manner. Some of the general provisions of the new form of contract, abstracted from the July issue of Public Works of the Navy, follow:

Percentage.—Unless provision is made in the contract to the contrary, the percentage shall be 10 per cent of the cost of that portion of the work performed by the contractor, and 5 per cent of the cost of that portion of the work which may be performed under subcontracts, subcontracts being defined as contracts entered into by the principal contractor which involve labor at the site.

Definition of "Cost of the Work."—The items of cost included under the term "Cost of the work," on which the percentages named in the contract shall be applied, are hereby defined as follows:

(a) All labor and material applied to both temporary and permament construction, exclusive of plant. Plant is hereby defined as large equipment or devices ordinarily moved from place to place and usually available on the completion of the work for use at other points. Examples of items included under the term "plant" are: Derricks, engines, boilers, air compressors, air locks, concrete mixers, pumps, hoists, power-driven tools, motors, etc. The cost of new plant purchased by the contractor for the work will be paid for on the basis of the purchase price less the appraised value of the plant at the time of completion of the work, such appraisal to be made by the officer in charge. The Government will reserve the right to retain such plant for Government use, in which case the full purchase price will be paid by the Government to the contractor. The contractor's commission or percentage shall not be applied to the cost of plant. In case of the utilization of old plant belonging to the contractor at the time of entering into the contract or secured for the work by the contractor on a rental basis the Government will pay to the contractor the rental price for such plant, the rental charge to be $2\frac{1}{2}$ per cent per month of the estimated cost of similar new plant.

(b) Loading and unloading of the contractor's plant, both at the contractor's yards and on the site of the work, together with transportation of same to and from the work provided that the distance from which and to which the plant shall be transported shall be subject to the approval of the officer in charge.

(c) Transportation to and from the site of the necessary skilled men for the economical and efficient prosecution of the work. The necessity for such transportation shall be determined by the officer in charge. Such transportation shall not involve repeated travel.

(d) Traveling expenses of any of the officers or engineers of the contractor when such travel is necessary.

The necessity for such transportation shall be determined by the officer in charge.

(e) Salaries of resident engineers, superintendents, timekeepers, clerks and other employes of the contractor's local office at the site of the work. No "overhead" expenses at the contractor's principal office or salaries of engineers or officers employed at the principal office shall be included in the cost of the work, nor shall the salaries of officers or engineers who may visit the work be included in the cost.

(f) All necessary expenses of the contractor's local office at the site of the work, such as telegraph and telephone service, expressage, postage, etc.

(g) Installation and dismantling of the contractor's plant, as well as the cost of necessary repairs and maintenance of same while employed on the work, provided that such repairs and maintenance shall not include ordinary wear and tear.

(h) All hand tools and supplies necessary for the work. Such tools and supplies shall be the property of the Government on the completion of the work, or the same may be removed by the contractor and allowance made therefor at an agreed-upon inventory value. In any case the course to be followed shall be subject to the approval of the officer in charge.

(i) The cost of liability insurance to protect both the public and the contractor from damage due to possible injury or loss incidental to the work and the cost of actual damages in excess of liability insurance; but no percentage shall be paid on such excess cost. Also the cost of fire insurance, in case the same is required by the Government.

(j) Engineering and drafting expenses actually incurred in connection with the preparation of detail drawings, in case such drawings shall be required by the Government. Such cost shall include the cost of prints. The force employed and the charges made for such drawings shall be subject to the approval of the officer in charge.

(k) The cost shall include the cost of any materials bought by the Government for the work, and the cost of any labor performed by the Government on the work, with the following exceptions: The cost of such work performed by the Government, upon which the contractor shall receive a percentage, shall not include work that may be performed in or on the work after the completion and acceptance of the work performed by the contractor; nor shall such cost include the cost of surveys and inspection performed by the Government, nor the cost of electric power, water, heat, light or similar service, furnished by the Government.

Contractor's Organization.—The contractor will furnish without charge other than the commission or fee provided for in the contracts, its business and purchasing system, engineering skill and experience, skilled organization, patented rights, and, generally, its ability to organize and equip the work with experienced men.

Monthly Vouchers.—Receipted bills for material purchased for the work, showing that payment therefor has actually been made by the contractor, shall be submitted monthly to the local officer in charge, who will examine the same and if found correct will certify as to their correctness on their face. Such certified bills for all material shall accompany monthly vouchers, which shall be forwarded by the officer in charge for payment to the disbursing office designated as the disbursing office for the contract in question. The officer in charge will also certify to the correctness of all pay rolls for labor applied to the job, and a certified copy of pay rolls concerned in each voucher will accompany same. All bills for material and pay rolls will be given a serial number or other identifying designation, and the pay vouchers shall bear on their face a list of the bills of material and pay rolls which accompany the voucher. Similarly all bills of whatever nature for which payment is made will be certified as correct by the officer in charge and will accompany the pay vouchers. The monthly voucher to be submitted by the officer in charge will also cover the agreed-upon commission or fee of the contractor. Paragraph 29 of the General Provisions is modified in that no reservation of 10 per cent of the cost of the work or of the fee is to be deducted from the monthly vouchers prepared by the officer in charge. The vouchers shall be submitted for approval by the officer in charge promptly after the first of each month, covering the work done during the preceding month. Final voucher shall be prepared and forwarded for approval immediately after completion and acceptance of the work.

Facilities.—The contractor shall afford sufficient facilities to the authorized representatives of the Government for the inspection of all work, materials, and supplies, and of all accounts, records of cost, etc.

Changes.—In case changes are directed by the Government, as provided in paragraph 17 of the General Provisions, and should such changes render unsuitable any material or labor, or both, already furnished or applied to the work by the contractor, the entire expense caused to the contractor thereby shall be determined by the Government and the contractor shall be reimbursed for such actual cost to him plus the percentage charge thereon.

Employment of Labor.—The officer in charge will approve the purchase of all materials for the work previous to the placing of orders therefor by the contractor, such approval to refer especially to the contemplated prices for such material. The interests of the Government will be safeguarded by the officer in charge by ascertaining that the contemplated prices for material are reasonable and that the contractor is purchasing to the best advantage. Similarly, in the employment of all labor under the contract, rates of pay shall be subject to the approval of the officer in charge, and only such pay will be authorized by him as is considered fair and equitable, and established as, or comparable with, prevailing rates of wages paid at the yard or station, or in the vicinity where the work is being performed. Rates of pay higher than those prevailing or established in the vicinity at the time of making the contract will not be authorized by the officer in charge, except on the approval of the Chief of Bureau of Yards and Docks. The contractor shall employ on the work no citizen of nations with whom the United States is at war, nor of nations allied to or friendly with nations at war with the United States. Furthermore, the officer in charge shall have the right to demand the immediate removal of any individual from the work, and where such demand is made the individual referred to shall be removed from the work and not again employed thereon. This right of removal shall apply to all work done by the contractor, whether on the site or elsewhere.

Eight-hour Law.—The contractor shall have the right, under the contract, to employ labor in excess of eight hours per day, in view of the present emergency conditions, such employment in excess of eight hours, however, to be paid for at the rate of not less than time and half time.

Discounts.—The contractor shall take advantage of all the discounts available, and the cost to the Government shall be based upon the actual net cost to the contractor after the deduction of such discounts.

Fire Insurance. — The contractor will protect against fire loss his own interests as distinct from risks on materials purchased and work performed and paid for by the Government. The cost of any fire insurance taken out by the contractor shall be considered as a part of the cost of the work, provided such insurance is approved by the officer in charge of the work.

Control.—The contractor shall have full control, under the direction of the officer in charge, of all labor employed on the work and, subject to the provisions in this addendum, shall have power to employ or discharge such labor as the contractor may deem necessary to the economical and efficient prosecution of the work, provided, however, that the rates of pay of such labor shall be subject to the approval of the officer in charge.

Subcontracts.—Previous to entry into any subcontract for any portion of the work, the contractor shall secure proposals for the work in question and submit the same to the officer in charge for his approval. Upon approval by the officer in charge, the contractor shall prepare agreements with the subcontractors and superintend the furnishing of all labor and material as may be required by the said agreements.

Cancellation of Contract.—Should the services rendered or work performed by the contractor prove at any time unsatisfactory to the Government, either because of insufficient diligence in the prosecution of the work, or on account of excessive cost of the work, or other reason, the Government shall be at liberty, after giving ten (10) days' written notice to the contractor, to terminate the contract, and in that event, the Government shall pay to the contractor the cost of the work up to such date not already paid for, plus its commission, as herein provided. Upon such payments being made by the Government to the contractor, the contract shall be terminated.

Bond.—The contractor shall furnish a bond in a penal sum of 5 per cent of the estimated total cost of the work, guaranteeing the faithful performance of the contract and the prompt payment to all persons supplying labor and material in the prosecution of the work. If the above bond shall involve any cost, such cost shall be borne by the contractor, and no part of the cost of the bond shall be included as a part of the cost of the work. A personal surety bond will be accepted provided the same is furnished by two satisfactory individual sureties.

According to a statement of the United States Shipping Board 433 ships of a total tonnage of 1,919,200 are now under contract, and 452 ships of a total tonnage of 2,968,000 are ready to be contracted for when funds are available. In addition negotiations are under way for 237 ships of a total tonnage of 1,281,400.

Labor Legislation of 1916

Perhaps the most striking legislation reproduced in the annual volume of labor laws of the Bureau of Labor Statistics, which has just been issued as Bulletin 213, is the act of Congress establishing 8 hours as a standard work day for employes operating trains on steam railroads in interstate commerce. Next to this may be placed the federal statute excluding from interstate traffic the products of the labor of children employed in mines or quarries under the age of 16, or in mills, canneries, factories, etc., under the age of 14 years; the hours of labor of children under 16 years of age must not exceed 8 per day, nor may such children work between 7 p. m. and 6 a. m.

State laws affecting the employment of children are also strengthened, as in South Carolina, where the age for employment in factories is raised from 12 to 14 years, while in Maryland the 14-year limit is extended to practically all industries except canning and packing. Laws regulating the employment of women are comparatively numerous in 1916, and it may be said that laws affecting women and children constitute the largest single group of laws appearing in the bulletin. In addition to statutes, there are important orders of industrial and welfare commissions fixing wages and hours for these classes of employes, and regulating the conditions of employment generally. Of special interest is a rule issued by the Oregon Industrial Welfare Commission fixing the hours of labor, minimum wages, and learning periods of women and minors, including males up to 18 years, in a wide range of employments

The effect of federal legislation on State action is apparent in the enactment of liability laws for railroad employes in South Carolina and Virginia, which follow in large degree the pattern of the federal statute on the subject. Most of the States of the Union have compensation laws, reproduced up to the end of the year 1916 in Bulletin No. 203 of the Bureau of Labor Statistics. A few States retain the liability doctrine, and the action of South Carolina and Virginia tends at least to harmonize Federal and State practice, though not coming up to the compensation standards generally accepted.

The idea of a requirement of artisans of certain classes to secure licenses continues to spread, laws of this class relating to barbers, plumbers, horseshoers, chauffeurs, electricians, and moving picture machine operators having been enacted during the year. The physical conditions of employment also received attention in the enactment of a number of regulations affecting factories and mines; while the settlement of labor disputes is the subject of an act of the South Carolina legislature. The latter act provides for arbitration on request, and gives a board of conciliation power to make investigations on its own motion, with compulsory attendance of witnesses, including the production of books and documents; a report may be published if a majority of the board approve.

Prices of Horses and Mules.—The average prices paid by the Government during the fiscal year ending June 30, 1917, for horses and mules for the use of the army were as follows:

Cavalry and riding horses	$149.97
Artillery and draft horses	184.53
Artillery horses, siege	236.02
Young horses for training at permanent remount depots	136.18
Draft mules, wheel	226.07
Draft mules, lead	184.30
Pack and riding mules	148.44

Bidding Prices on Public Work During Last Three Months

Contractors' Figures on Construction Undertakings in Various Sections of the United States

State Highway Construction in California.

The accompanying tabulation is a summary of the unit bids on the principal items involved in the construction of sections of State highway in California. The bids on the first six jobs were opened by the California Highway Commission on June 25; bids on Jobs 7 and 8 were received on July 16; and the bids on Jobs 9 and 10 were received on Aug. 6.

Job 1 covers Section C, of Route 7, Division III, and is located in Yolo County. The bidders in the order of bids given in the table were: C. H. & A. W. Gorrill, San Francisco; A. Tiechert & Sons, Sacramento, and Palmer & McBryde, San Francisco. On this job the State furnishes pipe railing, reinforced steel, wire mesh reinforcement, corrugated metal pipe, Portland cement, sand and coarse aggregate.

BIDDING PRICES ON EXCAVATION AND CONCRETE FOR STATE HIGHWAY CONSTRUCTION IN CALIFORNIA.

	Job 1.	Job 2	Job 3	Job 4.	Job 5.	Job 6.	Job 7.	Job 8.	Job 9.	Job 10.
Excavation Without Classification.										
Cubic yards	20,800	11,800	22,000	40,000	52,000	13,500	66,100	50,000	7,700	8,450
Engineer's estimate	$0.60	$0.50	$0.45	$0.75	$0.60	$0.52	$0.40	$0.30	$0.55	$0.55
Bidder No. 1	.80	.76	.80	1.05	.90	.60	.60	.45	.98	.95
Bidder No. 2	.65	.62	.75	.90	.65	.65	.50	.50	.85	.90
Bidder No. 3	.75	.70	....	....	.90	.77	...	.35	45	.45
Bidder No. 4	....	.70	....	....	.66	.75	...	...	1.00	.85
Bidder No. 5	....	.60	....	....	.75	.70	...	...	...	1.10
Concrete, Class A, Culverts and Monuments.										
Cubic yards	350	470	45	320	200	30	290	130	...	...
Engineer's estimate	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$13.50	$13.50	...	...
Bidder No. 1	12.50	15.00	15.00	9.62	15.00	15.00	16.00	15.00	...	..
Bidder No. 2	14.00	14.00	12.50	12.50	13.00	15.00	15.00	10.00	...	...
Bidder No. 3	15.00	15.00	....	....	10.00	14.00	...	15.00	...	...
Bidder No. 4	....	13.00	....	....	12.50	15.00	. .	...	...	...
Bidder No. 5	...	17.00	....	...	11.00	15.00	...	...	...	...
Concrete, Class A, Pavement.										
Cubic yards	19,550	8,715	10,710	10,300	2,500	5,300	11,300	13,820	9,046	7,540
Engineer's estimate	$3.75	$3.25	$3.80	$4.00	$3.75	$3.25	$5.00	$5.00	$3.50	$3.50
Bidder No. 1	3.80	3.81	4.00	4.43	4.90	4.60	8.40	8.75	4.15	6.39
Bidder No. 2	4.10	3.92	5.40	5.10	4.00	3.90	9.00	8.50	4.15	3.90
Bidder No. 3	4.00	4.10	....	....	3.95	4.00	....	5.72	3.82	3.82
Bidder No. 4	....	4.10	....	....	3.80	4.30	....	....	6.04	4.15
Bidder No. 5	....	4.60	...	. .	3.85	3.79	....	....	....	4.40
Wire Mesh Reinforcement (per 100 sq. ft.)										
Square feet	303,000	...	152,000	90,000	. .	....	....	...	90,000	30,000
Engineer's estimate	$0.10	....	$0.10	$0.10	.	. ..	.	....	$0.10	$0.10
Bidder No. 1	.25	....	.50	.30	...	...	....	....	.25	.40
Bidder No. 2	.60	....	.30	.20	. . .	....	....	....	.50	.20
Bidder No. 3	.30	....	....	1.00	....	..	....	....	.70	.70
Bidder No. 4	....	...	....	1.00	. .	...	....	....	.40	.50
Bidder No. 5	....	....	....	.17½	....	....	....	....	....	.25
Guard Rail										
Lineal feet	1,700	850	1,000	....	8,000	90	7,000	7,000	....	...
Engineer's estimate	$0.40	$0.40	$0.40	....	$0.35	$0.35	$0.45	$0.40	....	....
Bidder No. 1	.45	.75	.50	....	.50	.80	.45	.50	....	. ..
Bidder No. 2	.40	.60	.50	....	.50	.80	.50	.45	....	...
Bidder No. 3	.50	.70	....	....	.40	.60	....	.55	....	. ..
Bidder No. 4	....	1.00	....	....	.35	1.00	...	....	....	....
Bidder No. 5	....	.80	....	....	.50	.75	....	....	....	....

Job 2 covers Section B of Route 4, Division VI, in Tulare County. The bidders were L. G. Garnsey, Los Angeles, Cal.; T. S. Shafer, Los Angeles; Johnson & Shea Co., Oakland, Cal.; M. T. Shafer, Los Angeles; Lynn S. Atkinson, Jr., Los Angeles, Cal. The State furnishes steel reinforcement, cement, broken stone, sand, corrugated metal pipe.

Job 3 covers Section C of Route 2, Division V, in Monterey County. The bidders were Palmer & McBryde, San Francisco, and Tieslau Bros., San Francisco. On this contract the State furnishes corrugated metal pipe, pipe railing for culverts, reinforcing steel, Portland cement, sand and coarse aggregate.

Job 4 covers Section B of Route 8, Division IV, in Napa County. The only bidders were Worswick Construction Co., Vallejo, and Tieslau Bros. The State furnishes pipe railing, reinforcing steel, wire mesh reinforcement, corrugated metal pipe, Portland cement, sand and coarse aggregate, drain tile and broken stone, $72,016.

Job 5 covers Section A of Route 5, Division IV, in Alameda County. The bidders on this work were C. H. & A. W. Gorrill, San Francisco; Palmer & McBryde, San Francisco; P. H. Hoare, Oakland; Bates, Borland & Ayes, Oakland, and J. P. Holland, San Francisco. For this job the State furnishes reinforcing steel, cement, wire mesh reinforcement, sand and gravel, corrugated metal pipe.

Job 6 covers Sections A and B of Route 4, Division VI, Tulare County. Five bids were received, the bidders being Lynn S. Atkinson, Jr., Los Angeles; Geo. S. Benson & Sons, Los Angeles; T. E. Shafer, Los Angeles; Johnson-Shea Co., Oakland, and Leigh G. Garnsey, Los Angeles. The State furnishes the pipe railing, reinforcing steel, corrugated metal pipe, Portland cement, sand and coarse aggregate.

Job 7 covers Section E of Route 23, Division VII, in Los Angeles County. The bidders were Richard Rothwell, Los Angeles, and A. L. McCray, Los Angeles. The State furnishes the steel, cement and corrugated pipe for this job.

Job 8 covers Section D of Route 23, Division VII, Los Angeles County. The three bidders were A. L. McCray, Richard Rothwell and Tyron & Brain, Los Angeles. For this job the State furnishes pipe railing, reinforced steel, corrugated metal pipe, Portland cement.

Job 9 covers Section F of Route 2, Division V, Santa Barbara County. The bidders were Charles D. Tompkins, Los Angeles; Flinn & Treacy, San Francisco; Tryon & Brain, and Lynn S. Atkinson, Jr. The State furnishes the wire mesh reinforcement, Portland cement, sand and coarse aggregate.

Job 10 covers Sections G of Route 2, Division V, Santa Barbara County. There were five bids on this work, the bidders being Lyman S. Atkinson, Jr., Cooper Contracting Co., Los Angeles; Tyron & Brain, Los Angeles; Flinn & Treacy, Chas. D. Tompkins. The Portland cement, sand, broken stone and wire mesh reinforcement were furnished by the State.

Bituminous Macadam Roads in Jefferson County, Arkansas.

Bids were opened June 20 at Pine Bluff, Ark., by the Commissioners of Road Improvement District No. 14 of Jefferson County, Arkansas, for the construction of 39 miles of bituminous macadam roads, of which about 16 miles will have surfaced width of 12 ft. and the remainder a width of 10 ft. Humphreys & Tovey, Pine Bluff, Ark., are the engineers for the district.

The contract for furnishing the crushed stone and screenings was awarded to the Big Rock, Stone & Construction Co., Argenta, Ark., at the following bids: Rock, 48,016 cu. yd. at 96 ct. f. o. b. cars at plant; screenings, 1,714 cu. yd. at 96 ct. f. o. b. cars at plant. The freight and switching charges on the rock and screenings amounted to 67.5 ct. additional per cubic yard. The contract for furnishing the asphalt was let to Sam E. & C. J. Finley, Atlanta, Ga., at the following bid: 34,880 gal. at 6.46 ct. delivered at Pine Bluff, Ark., 245,080 gal. at 6.63 ct. delivered at Sherrill and Tucker, Ark., and 28,550 gal. at 7.15 ct. delivered at Ferda, Ark. The Barber Asphalt Co., at 14.5 ct. per gal., was the only other bidder for furnishing the asphalt. Sam E. & C. J. Finley were awarded the contract at 6.5 ct. per gal. for applying the asphalt; the other bidders on this particular item were: J. A. Perdue & Co., 6 ct.; N. B. Gregory, 5 ct.; Ralph P. Taylor, 6 ct.

The unit prices on the main features of the work were as follows: (1) Standing for bid of Wilson Construction Co., Little Rock. (2) C. E. Philpot, Pine Bluff. (3) E. A. Henslee, Pine Bluff. (4) J. A. Perdue & Co., Pine Bluff (awarded contract). (5) N. B. Gregory, Texarkana, Ark. (6) Ralph P. Taylor, Texarkana.

BIDS RECEIVED JUNE 20 AT PINE BLUFF, ARK., FOR CONSTRUCTING 39 MILES OF BITUMINOUS MACADAM ROADS IN JEFFERSON COUNTY, ARKANSAS.

	(1)	(2)	(3)	(4)	(5)	(6)
Clearing and grubbing, 41 acres	$125.00	$110.00	$115.00	$100.00	$100.00	$100.00
Earth excavation,* 144,250 cu. yd.	0.275	0.23	0.215	0.23	0.24	0.24
Fence moving, 25 miles	128.00	64.00	70.00	75.00	100.00	150.00
Hauling and placing corrugated iron culverts:†						
12-in. diameter, 1,289 lin. ft.	0.10	0.15	0.15	0.18	0.30	0.20
18-in. diameter, 1,248 lin. ft.	0.10	0.20	0.20	0.22	0.30	0.25
24-in. diameter, 1,072 lin. ft.	0.12	0.25	0.25	0.24	0.30	0.30
30-in. diameter, 672 lin. ft.	0.12	0.30	0.30	0.26	0.30	0.35
Hauling, Spreading, Rolling and Finishing Crushed Stone:‡						
0 to 1 mile haul, 8,232 cu. yd.	0.85	0.80	0.83	0.70	0.75	1.16
1 to 2 mile haul, 7,262 cu. yd.	1.15	1.10	1.13	1.00	1.10	1.46
2 to 3 mile haul, 5,484 cu. yd.	1.45	1.40	1.43	1.30	1.40	1.76
3 to 4 mile haul, 3,651 cu. yd.	1.75	1.70	1.73	1.60	1.75	2.06
4 to 5 mile haul, 3,651 cu. yd.	2.00	2.00	2.03	1.90	2.05	2.36
5 to 6 mile haul, 4,774 cu. yd.	2.25	2.30	2.33	2.15	2.40	2.66
6 to 7 mile haul, 5,211 cu. yd.	2.55	2.60	2.63	2.50	2.70	2.96
7 to 8 mile haul, 4,724 cu. yd	2.85	2.90	2.93	2.75	3.00	3.26
8 to 9 mile haul, 3,405 cu. yd.	3.20	3.20	3.23	3.00	3.30	3.56
9 to 10 mile haul, 1,622 cu. yd.	3.60	3.50	3.53	3.00	3.50	3.86
Hauling and Applying Screenings:						
0 to 1 mile haul, 294 cu. yd.	0.85	0.80	0.83	1.00	1.50	1.08
1 to 2 mile haul, 259 cu. yd.	1.15	1.10	1.13	1.50	1.85	1.38
2 to 3 mile haul, 196 cu. yd.	1.45	1.40	1.43	2.00	2.20	1.68
3 to 4 mile haul, 130 cu. yd.	1.75	1.70	1.73	2.50	2.50	1.98
4 to 5 mile haul, 130 cu. yd.	2.00	2.00	2.03	2.75	2.85	2.28
5 to 6 mile haul, 170 cu. yd.	2.25	2.30	2.33	3.00	3.20	2.58
6 to 7 mile haul, 186 cu. yd.	2.55	2.60	2.63	3.25	3.50	2.88
7 to 8 mile haul, 169 cu. yd.	2.85	2.90	2.93	3.50	3.80	3.18
8 to 9 mile haul, 122 cu. yd.	3.20	3.20	3.23	3.50	4.10	3.38
9 to 10 mile haul, 58 cu. yd.	3.60	3.50	3.53	3.50	4.40	3.68
Spreading earth binders, 247,000 sq. yd.	0.20	0.0125	0.015	0.01	0.03	0.02
Totals	$192,147	$136,282	$137,382	$130,949	$146,880	$160,089

*Free haul, 1,000 ft. †County furnishes culverts. ‡1 cu. yd. rock weighs 2,300 lb.

Earth Road Construction for Parmer County, Texas.

Bids were opened May 31 at Farwell, Tex., by the Commissioner of Parmer County, for the construction of 38 miles of earth roads, including reinforced concrete bridges and culverts. The contract was let to O. C. McElrath, Gilmer, Tex., at the following bid:

Solid rock excavating, per cu. yd.	$ 1.00
Loose rock excavation, per cu. yd.	.25
Fresno earth excavation 80,000 cu. yd., per cu. yd.	.14
Crowning, shaping and rolling, 2,000 100-ft. stations, per 100 ft.	2.50
Concrete, 550 cu. yd.:	
Class X per cu. yd.	17.00
Class A per cu. yd.	16.00
Class B per cu. yd.	15.00
Reinforcing steel in place, 40,000 lb., per lb.	.06

T. E. Huffman is County Highway Engineer.

Rapid Transit Contract, Philadelphia.

The Keystone State Construction Co., Philadelphia, was the only bidder July 24 for Contract No. 528, calling for work in connection with the new rapid transit scheme of that city. The work involved the construction of track floor, floor drains and foot walks in Front St., Kensington Ave. and Frankford Ave., from Callowhill St. to Dyer St. The bidding prices follow:

Work as shown on plans, lump sum	$890,000.00
Class B, 1:2:4 concrete, in floor, 200 cu. yd., per cu. yd.	20.00
Footwalk slabs, 2,000 sq. ft., per sq. ft.	.60
Steel reinforcing rods, 20,000 lb., per lb.	.08
Structural steel work, 20,000 lb., per lb.	.20
Bolts, clamps, nuts, washers, etc., 20,000 lb., per lb.	.20
Iron castings, 20,000 lb., per lb.	.20
Force account, $2,000, per cent added	30%
Aggregate of bid	$909,400 00

Concrete Walks and Curbs at Niagara Falls, Ont.

The city of Niagara Falls, Ont., W. C. Jepson, City Engineer, opened bids July 19 for constructing about 22,000 sq. ft. of concrete walk and 4,550 ft. of curb. The bidding prices were as follows:

Contractor.	Per Sq. Ft. of Walk. Cts.	Per Lin. Ft. of Curb. Cts.
V. C. Thomas*	19	24
Cook & Murray	22¾	23¾
L. Sacco	23	24

*Awarded contract.

Specifications call for foundation course of 4-in, of gravel or soft coal cinders; base course 3½-in. concrete, 1 part cement to 6 parts gravel; wearing surface, 1 in., 1 part cement to 2½ parts screened sand. Body of curb same as base course, curb 6 in. by 15 in., wearing surface 1½ in. thick carried down 8 in. Price per lineal foot of curb is in addition to price per square foot of walk where walk and curb are combined.

Earth Road Construction for McCormick County, South Carolina.

The McCormick County Highway Commission, for which M. E. Worrell is Engineer, opened proposals July 19 for road construction. The work was divided into four sections and bids were asked on each of these separately and on all sections as a whole. No bids were received on Section B, embracing Roads Nos. 2 and 3. The conditions relating to the various items on which bids were asked included the following:

Clearing and Grubbing—Medium work; only acreage actually cleared and grubbed to be measured.

Earth Excavation—Paid for as "one way"; free haul, 500 ft.; overhall, 2 ct. per cu. yd. sta.; material very good—clay and sandy loam; average, 4,000 to 5,000 cu. yd. per mile.

Solid Rock—Slate and shale in almost vertical strata; mean to shoot; light cuts.

Grader Work—Class A, 28 ft. wide; Class B, 26 ft. wide. No longitudinal movement of materials—merely crowning and ditching.

Concrete—U. S. O. P. R. specifications; long haul on sand; rock probably have to be shipped in on Sec. D at cost $3.50 f. o. b. cars siding per cubic yard.

Steel for reinforcing concrete to be furnished and placed by contractor.

Lumber for repairs of present bridges.

Vitrified Clay—No. 1 double strength, furnished by contractor.

Corrugated Metal—2-oz. spelter, 99.7 per cent purity, furnished by contractor.

Concrete Pipe—To be furnished by county. Price given is for hauling and laying only.

Guard Railing—Oak or cedar posts, 8 ft. c. to c.; two 2x6 wooden rails; one coat paint.

Top Soil and Gravel—1,000 ft. free haul; 1 ct. overhaul per cubic yard, sta.; measured in place compacted. If measured loose, 33½ per cent deducted.

The unit prices were as follows, (1) standing for bid of J. C. Brown, Montgomery, Ala., (2) for C. C. Jordan, Wadesboro, N. C., (3) R. G. Hill & Co., Kingston, N. C., (4) S. E. Lee Construction Co., Emporia, Va., (5) Alexander & Milford, Greenwood, S. C. (6) R. L. Peters & Bros., Knoxville, Tenn., (7) Bennett & Maloney, Chattanooga, Tenn., (8) Platt & Ross, Greensboro, N. C.

Sewer Construction, Tulsa, Okla.

Bids were opened July 23, by the city of Tulsa, Okla., H. H. Wyss, City Engineer, for three small contracts for constructing sewers. The work is to be paid for in cash. The bidding prices on this work were as follows, (1) standing for engineer's estimate, (2) for bid of C. O. & H. Frye, (3) Carl Pleasant, (4) Plummer Adams Co.:

Quantities	(1)	(2)	(3)	(4)
Sub-Main for Hillcrest Add.—Through Wakefield.				
1,092 lin. ft. 8-in. con. sewer pipe	$0.40	$0.40	$0.40	$0.36
425 cu. yd. earth excavation	0.65	0.55	0.65	0.63
255 cu. yd. shale excavation	1.75	1.50	1.70	1.63
170 cu. yd. rock excavation	3.30	2.80	3.25	3.45
3 manholes under 12 ft.	55.00	55.00	55.00	52.00
Sub-Main for Hillcrest Add.—East of Lewis.				
1,561 lin. ft. 12-in. con. sewer pipe	$0.65	$0.65	$0.64	$0.58
721 cu. yd. earth excavation	0.65	0.55	0.63	0.63
431 cu. yd. shale excavation	1.75	1.50	1.70	1.63
286 cu. yd. rock excavation	3.30	2.80	3.25	3.45
5 manholes under 12 ft.	55.00	55.00	55.00	52.00
1 manhole over 12 ft.	60.00	60.00	60.00	52.00
Sub-Main for Hillcrest Add.—Rockford to Zunis.				
3,600 lin. ft. 12-in. con. sewer pipe	$0.65	$0.65	$0.63	$0.58
940 cu. yd. earth excavation	0.65	0.55	0.64	0.63
470 cu. yd. shale excavation	1.75	1.50	1.70	1.63
940 cu. yd. rock excavation	3.30	2.80	3.25	3.45
12 manholes under 12 ft.	55.00	55.00	55.00	52.00
1 manhole connection	5.00	3.00	5.00	5.00
1 cu. yd. concrete creek cross	8.00	8.00	8.00	8.50

Stone-Concrete Substructure for Breakwater, Buffalo Harbor, N. Y.

There were only two bidders July 10 for constructing a stone-concrete substructure on the breakwater at Buffalo Harbor, N. Y., for the U. S. Government. The unit bids on this work were as follows, (1) standing for bid of Coast & Lakes Contracting Corp., 25 Broad St., New York City, (2) for Empire Engineering Co., Inc., Buffalo, N. Y.

	(1)	(2)
Removing old superstructure, 805 lin. ft.	$30.00	$18.25
Capping stone, 27,400 short tons	6.00	5.20
Rubble stone, 2,100 short tons	2.00	1.30
Mass concrete, 2,010 cu. yd.	10.00	8.00
Total	$212,850	$175,981

Levee Construction for Third Mississippi River District.

Bids were opened July 11 by the Mississippi River Commission, Third District, Vicksburg, Miss., for constructing about 1,265,00 cu. yd. of levee, of which 50,000 cu. yd. is riverside enlargement, 35,000 cu. yd. banquette and the remainder new work. The new levee will be constructed along the Arkansas River below Yancopin, Ark. The Hercules Co., Ltd., New Orleans, La., at 23.3 ct. per cubic yard, and Roach, Stansell & Co., Memphis, Tenn., at 29.8 ct. per cubic yard, were the only bidders. The low bid was accepted.

BIDS RECEIVED JULY 19 AT McCORMICK, S. C., FOR EARTH ROAD CONSTRUCTION FOR McCORMICK COUNTY.

	Section A, Road No. 1					Section C Roads 4 and 5.		Section D Roads 6 and 7.			All Sections			
Items.	Quantities.	(1)	(2)	(3)	(4)	Quantities.	(5)	Quantities.	(1)	(2)	Quantities.	(6)	(7)	(8)
Clearing and grubbing, acs.	10	$100.00	$85.00	$120.00	$100.00	2	$58.00	7	$100.00	$85.00	33	$50.00	$80.00	$90.00
Earth excv., cu. yd.	74,000	.27½	.28	.37	.32	28,000	.34½	86,000	.30	.28	273,000	.31	.45	.31
Solid rock excv., cu. yd.	400	1.25	1.00	1.65	1.00	100	1.50	700	1.10	1.00	4,200	1.00	.95	1.25
Grader work, ClassA, miles	2	675.00	250.00	475.00	160.00	...	....	...	....	....	2	350.00	350.00	150.00
Grader work, ClassB, miles	1	600.00	200.00	450.00	150.00	1	150.00	7	650.00	200.00	14	340.00	300.00	145.00
Concrete, Class A, cu. yd.	25	17.00	18.00	18.75	15.00	25	17.00	105	15.00	18.00	230	13.00	12.50	12.00
Concrete, Class B, cu. yd.	37	15.00	16.00	17.50	12.00	12	12.50	204	13.50	16.00	390	12.00	11.50	11.00
Concrete, Class C, cu. yd.	140	13.50	14.00	14.00	10.50	80	12.00	140	12.50	14.00	540	11.00	10.00	10.00
Concrete hand rail, cu. yd.	6	22.50	12.00	27.00	18.00	6	20.00	18	20.00	12.00	44	16.00	15.00	20.00
Steel, lb.	2,000	.07½	.10	.11	.10	2,000	.05¼	10,000	.07½	.10	21,000	.09	.10	.07
Lumber, B. M., 1,000 ft.	.....	.....	.....	.....	.....	...	....	8	50.00	†	10	48.00	40.00	45.00
12" vit. clay culv. pipe, l. ft.	20	.68	.60	.80	.75	50	.54	120	.68	.75	240	.68	.60	.55
15" vit. clay culv. pipe, l. ft.	310	1.00	.80	1.05	.95	230	.74	480	1.00	1.00	1,260	.90	.90	.80
18" vit. clay culv. pipe, l. ft	240	1.38	1.20	1.35	1.20	100	.97	180	1.38	1.30	670	1.20	1.20	1.00
24" vit. clay culv. pipe, l. ft.	80	2.50	2.25	2.20	2.00	20	1.77	50	2.50	2.25	250	1.30	2.00	2.00
12" cor. met. culv. pipe, l.ft.	20	1.75	1.46	1.75	1.60	50	1.25	110	1.75	1.45	230	1.55	1.60	1.50
15" cor. met. culv. pipe, l.ft.	310	2.00	1.84	2.05	1.95	230	1.52	480	2.00	1.85	1,260	1.95	1.90	1.75
18" cor. met. culv. pipe, l.ft.	240	2.50	2.20	2.50	2.00	100	1.72	180	2.50	2.20	670	2.35	2.35	2.20
24" cor met. culv. pipe, l.ft.	80	3.75	3.60	3.50	3.60	20	2.65	50	3.75	3.65	250	2.80	3.50	3.50
12" conc. culv. pipe, lin. ft.	20	.40	.24	.55	.45	50	.30	110	.40	.35	230	.35	.30	.40
15" conc. culv. pipe, lin. ft.	310	.50	.30	.65	.50	230	.35	480	.50	.28	1,260	.40	.40	.50
18" conc. culv. pipe, lin. ft.	120	.68	.35	.70	.55	50	.40	90	.68	.50	340	.60	.50	.60
20" conc. culv. pipe, lin. ft.	120	.80	.45	1.00	.60	50	.50	80	.90	.60	320	.90	.60	.70
24" conc. culv. pipe, lin. ft.	80	1.00	.75	1.25	.75	20	.60	50	1.25	.75	250	1.00	.75	.80
Guard railing, lin. ft.	5,000	.29	*	.50	.30	800	.25	1,200	.25	*	8,000	.40	.50	.25
Top and soil gravel, cu. yd.	10	.40	.35	.80	.55	10	.18	10	.40	.35	40	.48	1.75	.50

*Cost plus 10%. †Cost plus 1%.

Concrete Bridge for Newcastle County, Delaware.

The following bids were received July 31 by James Wilson, County Engineer, Wilmington, Del., for construction of a concrete bridge; (1) bid of A. S. Reed & Bro., (2) I. J. Hollingsworth:

	(1)	(2)
12-in. I beams in place per lb.	$0.06½	$0.08
Stagger rods in place, per lb.	.08	.16
Wire reinforcement in place, per sq. ft.	.08½	.03
Concrete in place, per cu. yd.	9.00	20.00
Pointed rubble masonry, per cu. yd.	9.00	15.00
Dashed rubble masonry, per cu. yd.	7.00	11.00
Excavation, per cu. yd.	2.25	1.20
Total to complete work	$3,279	$3,109

Concrete Arch Dam for City of New Brunswick, N. J.

Bids were opened July 17, by the Department of Public Affairs of New Brunswick, N. J., of which Asher Atkinson is City Engineer, for the construction of concrete arch dam across Weston's Mill Pond, near the city pumping station. The dam will be built in water having a maximum depth of about 19 ft. The itemized bidding prices on this work were as follows, (1) standing for bid of F. W. Schweers, Jr., Co., New York City, (2) C. R. Simpson, New York City, (3) Cadmus Construction Co., New York City, (4) Substructure Co., New York, (5) B. G. Coon Construction Co., Luzerne, Pa. (awarded contract), (6) T. H. Riddle, New Brunswick, N. J., and (7) Utility Construction Co.:

BIDS RECEIVED JULY 17 BY NEW BRUNSWICK, N. J., FOR CONSTRUCTING CONCRETE DAM.

Items.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wet excavation, 360 cu. yd.	$2.90	$3.00	$4.00	$2.60	$4.00	$2.50	$2.25
Dry excavation, 100 cu. yd.	1.50	1.47	2.00	1.90	1.60	2.50	2.75
Rock excavation, 100 cu. yd.	5.50	9.93	6.00	3.35	5.00	3.25	3.50
Plain concrete, 1,120	13.50	12.85	12.00	11.20	11.00	14.65	14.50
Reinforcing bars, 2,000 lb.	.08	.10	.10	.09	.12	.10	.09
Sluice gates, 3	600.00	436.00	500.00	450.00	200.00	350.00	300.00
Cofferdam and pumping	8,000	10,177	27,000	19,863	8,300	6,250	6,010
Grand total	$26,824	$28,298	$44,380	$35,398	$23,560	$25,383	$21,765

Concrete Road Construction for Dallas County, Texas.

Bids for the construction of 39,468 sq. yd. of reinforced concrete pavement on the Dallas-Fort Worth Pike and the Dallas-Coppell Road of the County Improved Road System were opened June 25 at Dallas, Tex., by J. F. Witt, County Engineer. The pavement was to be laid on a flat sub-grade, the average thickness of the surface being 5¼ in. at the edges and 7¼ in. at the center. The county furnishes cement to the contractor. Team haul to the work for this material was about 2 miles. Screened gravel cost $1.35 per cu. yd. f. o. b. job, and screened sand also cost $1.35 f. o. b. job. Chico stone cost $1.70 per cu. yd. f. o. b. cars, Dallas. The price for Knippa trap rock was $4.08 per cu. yd. f. o. b. cars, Dallas. The team haul for rock was 1¾ miles. Common labor at the time bids were taken was $2 per day and teams with drivers were $4 per day. The reinforcement for the pavement was 30 lb. per 100 ft. The unit bids on the work were as follows, (1) standing for bid of Vibrolithic Construction Co., Dallas (awarded contract), (2) M. C. Hurley, (3) Southern Paving Co., (4) Bramley Lanken Paving Co., (5) Healy Construction Co., (6) H. K. McCollum, (7) J. F. & J. B. Wills:

Pumping Station Foundations in Passaic Valley (N. J.) Intercepting Sewer.

Bids were opened by the Passaic Valley Sewerage Commissioners, Newark, N. J., on June 26 for the construction of foundations and connections for the Yantacaw pumping station, and on July 10 for similar work for the Wellington pumping station. The bidding prices on the first mentioned station are shown in the accompanying tabulation, (1) standing for Cadmus Construction Co., Inc., New York; (2) Harrison & Daly, New York; (3) O'Gara Construction Co., Newark, N. J.; (4) Louis L. Brown Co., Inc., New York; (5) J. F. Shanley Co., Newark, N. J. The bidders on the Wallington station work were: (1) Culp Co., Inc., Paterson, N. J.; (2) Linde & Griffith Co., Newark, N. J.; (3) Louis L. Brown Co., Inc., New York; (4) Carrington Construction Co., Passaic, N. J.

YANTACAW PUMPING STATION FOUNDATIONS AND CONNECTIONS.

	(1)	(2)	(3)	(4)	(5)
Earth excavation and refilling in trench for 24-in. concrete sewer, 460 lin. ft.	$60	$46.70	$37.00	$45.00	$40.00
Earth excavation for foundations for pumping station, suction sewer, etc., lump	53,000	12,194	31,000	16,500	22,000
Rock excavation in open excavation, 50 cu. yd.	3	8	5	4.50	6
Concrete masonry, Class A, 1:2:4, 250 cu. yd.	13.50	17.45	13.00	17.90	13.50
Concrete masonry, Class B, 1:2½:5, 1,350 cu. yd	9.00	15.70	11.00	9.25	10.00
Brick masonry with P. C. mortar, 30 cu. yd.	15.00	30.00	30.00	22.80	30.00
Riprap in place, 2,500 long tons	4.00	3.88	3.00	4.95	4.50
18 in. c. i. pipes and specials, valves, etc., lump	4,000	3,678	3,000	3,540	4,500
Timber piles in place, 20,000 lin. ft.	.40	.55	.60	.66	.65
Steel for reinforcement, floor frames, etc., in place, 70,000 lb.	.08	.10	.07	.114	.075
Broken stone road surfacing complete, 300 sq. yd.	1.50	1.75	2.50	1.55	1.50
Ventilating ducts and drains, lump	500	573	500	545	550
Tide gates, openings 30 in. x 30 in., 1 set of 2 gates, lump	1,200	642	800	738	200
Totals	$126,475	$113,352	$96,720	$93,914	$93,675

WALLINGTON PUMPING STATION FOUNDATIONS AND CONNECTIONS.

	(1)	(2)	(3)	(4)
Earth excavation and refilling, in trench, for 54-in. conc. sewer and for 36-in. conc. sewer, lump	$8,375	$3,350	$3,700	$4,500
Earth excav. for foundations for pumping sta., coal house, suction sewer, etc., lump	66,298	40,950	16,100	27,500
Rock excavation, in open excavations, 50 cu. yd.	.01	3.00	5.00	5.00
Concrete masonry, Class A, 1:2:4, 500 cu. yd.	15.00	9.00	16.50	11.00
Concrete masonry, Class B, 1:2½:5, 3,800 cu. yd.	5.00	8.50	11.25	8.50
Brick masonry with P. C. mortar, 30 cu. yd.	20.00	25.00	27.00	24.00
Riprap, in place, 1,500 long tons	1.00	2.50	4.60	3.25
C I pipes and specials, gate valves, meter, wall castings, etc., lump	9,200	11,900	12,030	9,400
Timber piles, for support of masonry structures, in place, 12,000 lin. ft.	.50	.40	.50	.45
Steel for reinforcement, floor frames, etc., in place, 260,000 lb.	.08	.075	.085	.07
Broken stone road surfacing, complete, 800 sq. yd.	1.50	1.70	1.80	1.40
Ventilating ducts and surface drains complete, lump	750	920	1,070	950
Tide gates, for openings 48"x48", one set of two gates, lump	800	950	1,100	800
Cobble stone gutters, complete, 150 sq. yd.	.75	2.00	1.60	2.50
Earth filling for grading about pumping station, 2,000 cu. yd.	1.00	.50	.50	1.10
Timber bulkhead, complete and in place, lump	7,200	11,450	10,910	10,400
Totals	$151,330	$137,770	$134,650	$124,490

BIDS RECEIVED JUNE 25 AT DALLAS, TEX., FOR REINFORCED CONCRETE PAVEMENT FOR COUNTY ROAD SYSTEM.

Item.	Quantity.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Concrete pavement, 1 course, sq. yd.	39,468	....*	$1.27	$0.87	$1.14	$1.12	$0.74	$0.74
Steel reinforcement, per sq. yd.	6,000	$0.13	0.40	+10%	+10%	0.15	0.19	0.20
Scarifying and shaping full crown width, linear foot	18,360	0.09	0.20	0.19	0.12	0.15	0.07	0.12
Guide posts in place, per post	220	2.60	4.80	2.50	0.95	2.50	1.50	1.80
Wood headers, per linear foot	800	....	0.24	0.15	0.15	0.10	0.12	0.16
Concrete pavement, 2-course M. W. or Chico stone	39,468	....*	0.24	0.94†	1.21	1.22†	0.86†	0.96†
Concrete pavement, 2-course trap rock	39,468	....*	....	1.00*†	....	1.35*†	0.97*†	....

*Vibrolithic Construction Co.—1-course pavement at $0.93, with tarred surface $0.99; 2-course pavement at $0.96, with tarred surface $1.02. County furnishes all cement free to contractor. †C = Chico crushed stone. *†Knippa trap rock.

Sanitary Sewers for Centerburg, O.

Bids were opened Aug. 13 by the village of Centerburg, O., for labor and material for constructing about 5,700 lin. ft. of 6-in. sewer. The Richards Engineering Co., Columbus, O., are the Consulting Engineers. The soil was of the average condition. Pipe is in 3-ft. lengths, with deep and wide sockets. The only bidders were Wm. H. Ralston, Mt. Vernon, O., and Blinn & Graham, Mt. Vernon. The contract was awarded to the first mentioned contractor. The unit prices were as follows, (1) standing for bid of Ralston, and (2) for bid of Blinn & Graham:

	(1)	(2)
6-in. sewer, 4 to 6 ft. deep, 265 lin. ft.	$0.65	$0.50
6-in. sewer, 6 to 8 ft. deep, 4,110 lin. ft.	.93	1.00
6-in. sewer, 8 to 10 ft. deep, 665 lin. ft.	1.10	1.20
6-in. sewer, 10 to 12 ft. deep, 215 lin. ft.	1.45	1.70
6-in. sewer, 12 to 14 ft. deep, 225 lin. ft.	1.60	2.00
6-in. sewer, 14 to 15 ft. deep, 250 lin. ft.	1.80	2.50
8-in. sewer, 4 to 6 ft. deep, 55 lin. ft.	.75	.70
8-in. sewer, 6 to 8 ft. deep, 260 lin. ft.	1.03	1.10
8-in. sewer, 8 to 10 ft. deep, 220 lin. ft.	1.20	1.40
8-in. sewer, 10 to 12 ft. deep, 165 lin. ft.	1.50	1.90
8-in. sewer, 12 to 14 ft. deep, 300 lin. ft.	1.90	2.20
8-in. sewer, 14 to 15 ft. deep, 65 lin. ft.	1.90	2.80
6-in. single Y in place, 27	.80	.80
6-in. double Y in place, 48	.80	.80
6-in. 45° elbow in place, 14	.80	.80
8-in. x 6-in. x 6-in. Y in place, 10	1.25	1.10
8-in. x 6-in. x 6-in. double Y in place, 7	1.25	1.10
8-in. x 6-in. double Y in place, 8	1.25	1.10
6-in. riser pipe, 43 lin. ft.	.30	.30
Standard manhole, 6 to 8 ft. deep, 11	45.00	50.00
Standard manhole, 8 to 10 ft. deep, 1	60.00	60.00
Standard manhole, 10 to 12 ft. deep, 1	60.00	70.00
Standard manhole, 14 to 15 ft. deep, 1	90.00	80.00
Drop manhole, 6 to 7 ft. deep, 1	45.00	60.00
Drop manhole, 12 to 13 ft. deep, 1	70.00	100.00
Drop manhole, 14 to 15 ft. deep, 1	85.00	110.00
Standard flush tank, 8 to 9 ft. deep, 1	85.00	90.00
Combined F. T. & M. H., 7 to 8 ft., 1	85.00	140.00

Bituminous Macadam for Jackson County, Missouri.

Bids were opened June 22 at Independence, Mo., by the Commissioners of Jackson County, Missouri, O. C. Sheeley, County Surveyor, for the construction of 35,600 sq. yd. of bituminous macadam wearing surface on the Independence Road. The unit prices on this work were as follows:

	Per sq. yd
J. Jaicks & Co.	$0.90
Chapman Construction Co.	.99
McInerney	1.25
McTernan-Halpin	.99½
Wm. Dwyer	.89*
J. Sutherland	.97½

*Recommended for acceptance.

The above prices are on bituminous macadam, using the best quality of Horse Shoe Brand Asphaltic Cement or its equal.

State Highway, California.

Bids were opened Aug. 20 at Sacramento, Cal., by the State Highway Commission for the construction of Section C, of Route 3, Division II, of the state highway system in Shasta County. For this job the state furnishes the pipe railing, reinforcing steel, portland cement, fencing material and corrugated pipe. The bidding prices are given in the accompanying tabulation, (1) standing for engineer's estimate, (2) for bid of Frederick Rolandi, San Francisco, (3) Richard Rothwell, Los Angeles, (4) Palmer & McBryde, San Francisco, (5) Robert Sherer, Los Angeles, (6) Bechtel, Quayle & Fontaine, San Francisco, (7) J. F. Fitspatrick, Sacramento, (8) Municipal Improvement Co., Richmond, Cal.:

State Highway in Washington.

Bids were opened June 25 by the State Highway Commission at Olympia, Wash., for the construction of 9,400 ft. of the Inland Empire Highway, the section extending west from the Idaho State line in Whitman County. The unit bids on this work were as follows, (1) standing for Dan Crevling, Walla Walla, Wash., (2) for Spokane Asphalt Macadam Paving Co., Spokane, Wash., (3) for G. L. Stickler, Pullman, Wash., and (4) for Mitchell Bros., Spokane, Wash.:

Item and Quantity.	(1)	(2)	(3)	(4)
Common excavation, incl. haul of 400 ft., 17,340 cu. yd.	$0.28	$0.29	$0.25	$0.22
Loose rock excavation, incl. haul of 400 ft., 1,700 cu. yd.	.60	.60	.58	.55
Solid rock excavation, incl. haul of 400 ft., 3,300 cu. yd.	1.40	1.20	1.25	1.38
Overhaul on any of above material, per each 100 ft., 4,780 cu. yd.	.04	.02	.01½	.02
Concrete, first class, 4.9 cu. yd.	25.00	23.00	19.00	22.00
Concrete, second class, 14.7 cu. yd.	23.00	21.00	18.00	20.00
Steel reinforcing bars in place, 4,110 lb	.11	.10	.11	.10
Plain concrete pipe in place, 12" dia., 36 lin. ft.	1.75	1.60	.85	1.20
Reinforced concrete pipe in place, 18" dia., 118 lin. ft.	2.20	2.75	1.85	3.20
Reinforced concrete pipe in place, 24" dia., 122 lin. ft.	3.90	4.00	2.85	4.00
Reinforced concrete pipe in place, 30" dia., 30 lin. ft.	5.00	5.00	3.50	5.00
Gravel or crushed rock in place, 28.50 cu. yd.	1.90	2.30	2.00	2.20
Totals	$18,879	$19,336	$17,276	$17,854

Reinforced Concrete Pavement at Jenkins, Ky.

Bids were opened July 24 by the city of Jenkins, Ky., L. B. Ablott, City Engineer, for street paving, the contract being awarded to the Phelps-Post-Guyn Co., Lexington, Ky., at the following bid:

Earth excavation, per cu. yd.	$0.60
Rock excavation, per cu. yd.	3.50
Reinforced concrete pavement, 4,000 sq. yd., per sq. yd.	2.25
Manholes, 2	50.00
Curb inlets and catchbasins, 10	60.00
Curb "B," per lin. ft.	.85
Curb "C," per lin. ft.	.80
Concrete sidewalk, 10,900 sq. ft., per sq. ft.	.17
Macadam roadway, 1,550 sq. yd., per sq. yd.	.60
10-in. storm sewer, 135 lin. ft., per lin. ft.	.95
12-in. storm sewer, 700 lin. ft., per lin. ft.	1.05
18-in. storm sewer, 310 lin. ft., per lin. ft.	1.35

The work involves about 2,450 cu. yd. of excavation. The concrete pavement will be a 1:2:3 mix and will have 3,750 lin. ft. of integral curb. The city will furnish rock without cost in the natural deposit. The work will require the quarrying and crushing of about 1,200 cu. yd. of limestone rock.

Vitrified Tile Sewers, Gary, Ind.

Bids were opened June 25 by the city of Gary, Ind., for constructing two short lengths of vitrified tile sewer. The work was in sand and the average cut was 12.4 ft. On both jobs water will be encountered. The unit bid on local sewer 67, requiring 1,084 lin. ft. of 12-in. vitrified tile, was as follows: John Hamilton, $2.30; James Gamble, $2.20. On local sewer 68, requiring 590 lin. ft. of 12-in. vitrified tile, John Hamilton bid $2.35 per lineal foot. Bids were opened July 30 on two other local sewer jobs. On local sewer No. 69, requiring 1,264 ft. 12-in. vitrified tile, the bids were: M. W. Holben, $1.70; John Apostol, $1.85; John Hamilton, $1.85, and James Gamble, $1.87.

BIDS RECEIVED AUG. 20 BY CALIFORNIA STATE HIGHWAY COMMISSION FOR SECTION OF ROAD IN SHASTA COUNTY.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excavation without classification, 151,000 cu. yd.	$ 0.70	$ 0.82	$ 1.00	$ 0.80	$ 0.77	$ 0.91	$ 0.75	$ 1.14
12-in. corr. metal pipe, 2,000 lin. ft.	.60	.60	.60	.80	.50	.70	.65	1.00
18-in. corr. metal pipe, 1,700 lin. ft.	.75	.80	.75	.90	.50	.85	.90	1.25
24-in. corr. metal pipe, 900 lin. ft.	.90	1.00	.90	1.00	.50	1.00	1.15	1.50
Portland cement concrete, Class "A" (Cul.), 1,500 cu. yd.	15.00	16.00	16.00	17.50	18.75	17.00	16.00	15.00
Portland cement concrete, Class "C," 100 cu. yd.	10.00	15.00	16.00	17.50	16.00	15.50	12.00	12.00
Rubble masonry, 750 cu. yd.	6.00	5.00	8.00	10.00	10.00	8.00	7.00	10.00
Dry rubble masonry, 300 cu. yd.	5.00	4.00	6.00	8.00	4.50	6.00	5.00	6.00
New property fences, 1.5 miles	175.00	300.00	200.00	175.00	250.00	210.00	200.00	2,250.00
Moving and resetting property fences, 1.5 miles	175.00	300.00	200.00	200.00	300.00	280.00	200.00	2,500.00
Slope paving, 200 cu. yd.	3.50	3.00	4.00	10.00	6.00	6.00	14.00	8.00
Monuments, 610, each	1.00	1.50	1.00	1.00	1.50	1.25	1.00	1.00

Sanitary Sewers, Frankfort, Ill.

Bids were opened June 27 for constructing sanitary sewers for the village of West Frankfort, Ill., for which P. B. Wilson, Marion, Ill., is the Engineer. The unit prices on this work are shown in the accompanying tabulation, (1) standing for bid of Keeley Bros., East St. Louis, Ill.; (2) J. E. & B. S. Crain, Murphysboro, Ill.; (3) Hoeffken Bros., Belleville, Ill.; (4) Dunlap-Dippold Co., Edwardsville, Ill.; (5) Katz Construction Co., Omaha, Neb., and (6) Foulkes Contracting Co., Terre Haute, Ind.

BIDS RECEIVED JUNE 27 FOR SANITARY SEWER CONSTRUCTION AT WEST FRANKFORT, ILL.

	(1)	(2)	(3)	(4)	(5)	(6)
6-in. vitrified pipe, 21,988 lin. ft.	$0.35	$0.41	$0.42	$0.55	$0.40	$0.51
8-in vitrified pipe, 50,974 lin. ft.	.56	.58	.60	.65	.50	60
10-in. vitrified pipe, 17,039 lin. ft.	.85	.64	.78	.75	.75	.83½
12-in. vitrified pipe, 8,269 lin. ft.	1.10	.75	.98	.86	.80	.92
15-in. vitrified pipe, 2,289 lin. ft.	1.12	1.09	1.25	1.00	1.10	1.36
18-in. vitrified pipe, 4,121 lin. ft.	1.55	1.39	1.59	1.35	1.50	1.59
10-in. C. I. P., Class A, 40	2.25	2.62	1.85	2.75	2.00	3.46
15-in. C. I. P., Class A, 210	3.40	3.62	3.25	4.70	4.00	7.50
18-in. C. I. P., Class A, 100	5.50	3.69	5.00	5.00	6.00	6.15
Slab top brick, M. H., 5	45.00	45.00	45.00	38.00	55.00	45.00
Arch top brick, M. H., 191	45.00	45.00	45.00	41.00	50.00	45.00
Brick, F. T., 11	120.00	85.00	115.00	80.00	100.00	120.00
Concrete, F. T., 17	110.00	85.00	120.00	90.00	100.00	115.00
6-in. lamp hole, 27	6.00	5.25	6.50	7.00	5.00	5.50
8-in. lamp hole, 16	7.00	7.00	7.50	8.00	5.00	6.50
Concrete bulkhead, 1	63.00	52.50	56.00	70.01	50.00	35.00
Disposal plant, 1	6,300	5,282	8,358	7,640	9,400	6,600

Paving, Gary, Ind.

The following bids were received July 30 by the city of Gary, Ind., W. P. Cottingham, City Engineer, for paving alley from 22nd Ave. to 24th Ave., (1) Gary Construction Co., (2) F. C. McVey & Co.:

Items.	(1)	(2)
2,050 sq. yd. Barr brick pavement (on sand)	....	$1.60
2,050 sq. yd. Barr brick pavement (on slag)	....	2.30
2,050 sq. yd. Barr brick pavement (on stone)	$2.30	2.30
2,178.5 sq. yd. concrete pavement (including lip)	2.00	2.00
44.4 sq. yd. macadam pavement removed	.40	.50
17.8 sq. yd. brick pavement removed	.40	.50
528.9 sq. yd. sidewalk	1.25	1.30
2,400 lin. ft. curb	.55	.58
660 lin. ft. house connections, 6-in.	2.00	2.10
80 lin. ft. header	.30	.35
637 cu. yd. grading	.50	.60
7 manhole covers reset	2.00	4.00
2 gutter inlets	35.00	30.00

Earth Road Construction, Mingo County, West Virginia.

Bids were opened Aug. 4 at Williamson, W. Va., by the County Court for the construction of 35 miles of earth roads and appurtenant structures. The contract was awarded to the Vaughan Construction Co., Shawsville, Va. The unit prices on the work were as follows, (1) standing for bid of Vaughan Construction Co., (2) for bid of Waugh & Martin, (3) Toney Pietro and (4) Zanda & Mucisk:

	(1)	(2)	(3)	(4)
Excavation, unclassified	$0.74½	$0.98	$0.80	$0.84½
Rubble masonry	6.00	10.00	8.00	7.50
Reinforced concrete	20.00	16.00	12.00	18.00
Plain concrete	12.00	14.00	10.00	14.00

Blake Taylor, Williamson, W. Va., is County Road Engineer.

Drainage Ditch, Adams County, Iowa.

O. P. Herrick, Des Moines, Ia., has been awarded contract for constructing the East Nordaway Ditch for Adams County, required for straightening the channel of the East Nordaway River. The ditch will be 2.77 miles long and will have a 12-ft. bottom width, ½ to 1 side slopes and 12-ft. berms. The bids received Aug. 17 were as follows: O. P. Herrick, 11.59 ct.; Moffett Construction Co., Des Moines, Ia., 13.5 ct.; J. H. Boise & Son, Omaha, Neb., 15.95 ct.; S. O. Briggs Co., Omaha, Neb., 14.5 ct.

Brick Pavement, Glencoe, Ill.

Bids were opened July 5 by the Board of Local Improvements of Glencoe, Ill., of which Windes & Marsh are Village Engineers, for paving Glencoe Road from Harbor St. to South Ave. with brick. Edward M. Laing, Highland Park, Ill., was the only bidder and was awarded the contract at $13,236. The engineers' estimate and the bidding prices are shown in the accompanying tabulation, (1) standing for the estimate and (2) for the bid:

	(1)	(2)
4,800 sq. yd. brick wearing surface, 2" sand and cement cushion, grout filler	$1.83	$1.83
4,300 lin. ft. 7"x20" Portland cement curb	.50	.60
90 lin. ft. 7"x16" Portland cement end curb	.50	.50
300 cu. yd. crushed stone filling	2.00	2.10
120 cu. yd. stone screenings to fill voids	2.00	2.10
18 catch basin covers renewed and adjusted	20.00	20.00
2 manhole covers renewed and adjusted	20.00	20.00
Grading, cleaning, scarifying foundation	500.00	500.00
Adjusting 100 ft. of sidewalk approaches	.....	.30
Adjusting 3 water gate boxes	.....	5.00

Steel Bridge Work for Jefferson County, Alabama.

Bids received June 21 by S. R. Batson, County Highway Engineer, Birmingham, Ala., for rebuilding a 192-ft. steel span bridge over the Locust Fork of Warrior River ranged from 8 ct. per pound for steel erected to 8¾ ct. The contract was awarded to the Southern Bridge Co., Birmingham, the lowest bidder. The other bridge companies who bid on this work were the Virginia Bridge Co., the Nashville Bridge Co., and the Vincennes Bridge Co.

Well Drilling for Cuba City, Wis.

Bids were opened July 12 by Cuba City, Wis., for drilling a well. The only bids received for this work were as follows:

	W.L.Thorne&Co., Flatteville, Wis.	M. T. Peterson, Madison, Wis.
12-in. well cased, 250 lin. ft.	$10.00	$10.00
10-in. hole, 500 lin. ft.	4.50	5.50

Personals

James C. Nagle has been appointed dean of engineering and professor of civil engineering in the Agricultural and Mechanical College of Texas, succeeding D. W. Spence whose death occurred in June. Mr. Nagle is a Virginian by birth but most of his life has been spent in Texas. He graduated from the University of Texas in 1889 with a B. S. degree in engineering, and obtained an M. A. degree in 1892. In the same year he obtained a C. E. degree from the Western University of Pennsylvania, now the University of Pittsburgh, and in 1893 an M. C. E. degree from Cornell. He was a professor of civil engineering in the Agricultural and Mechanical College of Texas for about twenty years and in 1911 was also made dean of engineering. He resigned from this position in 1913 to become chairman of the Texas board of water engineers, and has occupied that position since then. During his professional career he has often been engaged on construction work of various kinds, principally railroad, bridge and irrigation work. Mr. Nagle is the author of a field manual for railroad engineers and of numerous technical papers. He is a past president of the Texas Association of Members of the American Society of Civil Engineers; past president of the Texas Academy of Science, and a major in the Engineers Reserve Corps.

M. W. Serby, former contracting engineer for the Ochs Construction Co., Allentown, Pa., has resigned to accept position as general manager of the newly organized Wm. Serby Co., Builders, Washington, D. C. The new concern will handle general contracts in all classes of building construction.

W. B. Reed, formerly assistant city engineer of Roanoke, Va., has been appointed city manager of Portsmouth, Va., for a 3-year term. His salary will be $4,000 for the first year, $4,500 for the second and $5,000 for the third year.

Geo. H. Willitts, for the past three years a member of the firm of Bartholow-Willitts Engineering Co., has been appointed city engineer of Galveston, Tex.

Obituaries

Arthur Kneisel, National Treasurer for the American Association of Engineers, died in Chicago on Aug. 17. He was one of the original promoters of the Association and was secretary up to this year. As a writer of technical articles he always stood for the principal of "elevating the Engineering Profession and securing recognition for the Engineer." Mr. Kneisel was born in Lexington, Ky., in 1880, and received his early education in the Lexington schools, later graduating from the University of Kentucky. He came to Chicago over 15 years ago and was engaged as a Telephone Engineer and Patent Attorney. At the time of his death, he was President of the Utilities Development and Sales Co.

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Lewis S. Louer Becomes One of the Owners of Engineering and Contracting

Through the purchase of half the common stock of Engineering and Contracting, Lewis S. Louer becomes joint owner with Halbert P. Gillette of all the common stock of this company. Mr. Louer assumes the business management of this publication, and Mr. Gillette remains chief editor, a position that he has held for nearly 12 years.

Mr. Louer is a member of the class of '94, Cornell University, and has been engaged in the field of technical journalism since 1895. Starting in the advertising service department of the Engineering and Mining Journal (1895-6), his activities have been entirely on the business side of journalism. From 1896 to 1902 he was advertising manager of Cassier's Magazine, a mechanical engineering periodical. In 1902 Mr. Louer became western manager of Engineering Record, with headquarters at Chicago, and held that position for 10 years, when he resigned to become western manager of Sweet's Catalogue Service, a position that he has held until the present time.

As a result of the recent consolidation of Engineering News and Engineering Record, there are now but two civil engineering weeklies of national circulation —Engineering News Record, published in New York City, and Engineering and Contracting, published in Chicago. The publishers have no further announcement to make at this time, other than to say that Engineering and Contracting will continue to be edited and published as a weekly engineering and contracting paper covering the entire civil engineering field and coincidently providing four rotated monthly magazines and a quarterly which may be subscribed for separately, namely:

(1) Road and Street Monthly issue (first Wednesday);
(2) Waterworks and Hydraulic Monthly issue (second Wednesday);
(3) Dirt Mover and Pit Owner Monthly issue (third Wednesday);
(4) Building and Structural Monthly issue (fourth Wednesday);
(5) Price and Market Quarterly (fifth Wednesday).

The Non-Reading Engineer

For most students one very difficult part of a college course in engineering is the mathematics and its applications. Consequently it absorbs a large part of student time, and by doing so it often engenders the belief that engineering is primarily an application of the principles of quantitative reasoning. Some engineers seem never to outgrow the college-formed habit of regarding qualitative data and reasoning as belonging to a lower heaven than mathematical data and quantitative deduction. Certain it is that the average graduate engineer is prouder of his mathematical knowledge than of his store of qualitative facts. Indeed not a few disdain to accumulate systematically a knowledge of the sort that any foreman may acquire merely by reading.

Let any practicing engineer review in detail the nature of his daily work for a month, and he is apt to be surprised to note what a great preponderance of non-mathematical knowledge he applies. Road and street designing, for example, involves vastly more horse-sense than mathematics. Highway building, aside from the surveying, is little else than the following of precedents and the systematic studying of conditions. So, many an excellent road engineer is "self-educated." By which is meant self-driven to the sources of education—the books and periodicals. No man is really self-educated in any other sense of the term.

In our editorial trips we are incessently impressed by the fact that not all engineers have read extensively, for we see many of them daily doing things in an uneconomic—often in an obsolete—manner, in spite of the fact that the technical press has repeatedly presented far better designs and methods. These are the men who are "too busy to read." Having been "educated" years ago, they have gradually become less educated than many a man who has never enjoyed the opportunity of being taught all of engineering in four college years.

"Daylighting" a Mountain Road

Sharp curves of mountain roads are danger factors to which engineers are giving serious thought, the more serious the longer the road, the greater the number of abrupt turns and the steeper the hill slopes. The last named element, a steep sidehill, is the cause of many collisions of automobiles; for timid drivers hug the "inside" of the roadway, regardless of their right to be there.

In a trip over the Ridge Road in California the editor recently saw an ingenious and effective method of reducing the number of collisions. The sidehill at each sharp curve was excavated so as to "daylight the curve." This consists in widening the sidehill cut, but not carrying the cut clear down to the grade of the road. The cut is carried down to within 3 ft.

of grade, and a bench or berme of earth is left, over which the automobile driver can look. Then if the driver is hugging the hillside, he can, nevertheless, see an approaching car in time to swing out of its way.

Experience has taught the engineers of the California Highway Commission that if they widen steep sidehill cuts on sharp curves in the ordinary way; that is, by widening the roadway, cars still continue to hug the sidehill and drivers are unable to see approaching vehicles much better. The new method of "daylighting" is a decided improvement.

Suggested Theses for Senior Students of Civil Engineering

The Portland Cement, Association, through its consulting highway engineer, Mr. A. N. Johnson, has recently written professors of civil engineering in 110 colleges suggesting certain theses for senior students and offering to assist the students in securing the desired data. The following are suggested titles:

1. Methods and Effects of Various Ways of Finishing Concrete Pavements.
2. Various Factors That Influence the Making of Good Concrete.
3. Methods to Determine the Wear of Concrete Pavements.
4. Methods to Determine the Relative Value of Various Aggregates for Use in Concrete Pavements.
5. Effect of Frost Action on Road and Pavement Design.
6. Investigation of Pavement Temperatures.
7. Equipment Required for Concrete Work.

The automobile and the motor truck are fast giving an importance to road location and design that is not even second to that of railways. Many civil engineers predict that in the next decade more money will be expended on roads and streets than on any other class of public works. It is well, therefore, to turn the attention of an increasingly large number of civil engineering students toward highway work. This can be effectively done by assigning theses like those above suggested, and by coincidently insisting that the writers of such theses shall first make a broad reconnaissance of highway literature. The Portland Cement Association offers to aid the student in such a survey of the field, and doubtless other manufacturing associations will be glad to give similar assistance.

Lack of Courage in Criticising Society Publications

An experienced member of the American Society of Civil Engineers asks us why no one ever criticises waste of society money in publishing long papers replete with details of slight value to the members. Specifically he names a 300-page paper on the measurement of water by salt solutions. He says:

> I waded through this stuff until I got nervous prostration. The [annual] volume cost $50,000 for publication, and as one-fifth was devoted to this paper, we paid $10,000 for this "dope." Yet nobody says a word.

We shall not attempt to pass judgment on the paper in question. But even if this particular monograph does not merit the caustic criticism that our reader gives it—and he is a competent hydraulic engineer—it is a fact that many society publications cause unjustified expenditures of society funds. Yet rarely has any one the courage to protest. Each of us is apt to feel that the enemies he will make by a criticism of this sort will surely do us harm some day, and that the harm will far outweigh the personal gain from eventually securing improved and cheaper volumes of society transactions.

When an engineering periodical voices editorial criticism of the management of an engineering society, it is immediately and indignantly rebuffed for being a meddler in the affairs of others. So, between society members who dare not and editors of periodicals who care not, there is none left to speak a frank and severe word even when such a word is badly needed for the good of all. It is a pity, for who is there among us who may not profit from wholesome criticism, bitter though it may be?

Society papers often contain test data in great detail and of great value, but it usually serves every purpose to summarize the results in the published transactions. The original typewritten paper, with its mass of supporting data, should be indexed, bound and placed in the library for reference. The printed abstract of the paper should indicate the nature and extent of the original paper, and should give so complete a statement as to the matter not printed that the reader may judge whether it will repay him to go to the original or not.

Civil Engineers Should Lead in Securing Revision of Pavement Ordinances

Where a city is poorly paved, it will usually be found that the pavement ordinance is in need of revision. In most cities there are two serious defects in pavement ordinances: First, the assessment for a pavement must be paid, in one installment, instead of being spread over a term of years. Second, the abutting property owner bears the entire cost of a new pavement.

Four years ago in San Francisco a new street-improvement ordinance went into effect, making it possible for the property owner to pay for a new pavement in 10 annual installments plus a small interest charge. As a result the amount of new pavement annually laid has increased 20 per cent.

Civil engineers will perform a great public service if they will take the lead in arousing the public to the desirability of revising pavement ordinances. Let the slogan be: Spread the pavement burden. It should be spread over the entire city and over a term of years.

A Hint on Grading a Sidehill Road

There are relatively few road builders who know how to grade a road on a steep side hill in the most economic manner. If the hill is so steep that a team of horses can not travel along it, one ordinarily sees a gang of pick and shovel men excavating the roadway, and not infrequently the men carry the excavation to grade without the assistance of horses or machinery. A road builder experienced in mountain work may first attack a steep side hill by hand work, it is true, but he does so only to build a very narrow path along which a single horse can walk. Thereafter there is no more picking and shoveling.

A pioneer path, as it may be called, is first graded by hand on the side hill along the upper slope stakes. Then a one-horse side-hill plow starts plowing and widening the path to about 3 ft. by casting the earth down hill. The next step is to use a light single-horse V. The V should be shod and have a sharp cutting edge at the front, and should be so attached to the single-tree as to tend to crowd into the side of the hill. After grading a width of about 5 ft. a two-horse plow can be used, followed by a two-horse V to shove the earth down hill. The next step is to use a light road grader drawn by 2 to 4 horses.

The foregoing applies to roadways up to, say, 12 ft. wide. If the road is wider and fairly long a steam shovel or a power scraper is usually more economic than team work.

Two Narrow Roads Instead of One Wide Road

In Italy there are numerous single-track roads through the mountains, whereon traffic is permitted to travel only in one direction. This of course necessitates two parallel roads to accommodate traffic in opposite directions, but it has been found not only that two narrow roads can usually be built cheaper than a single wide road, but that there are fewer accidents, for collisions are impossible. A narrow side-hill cut can often be made entirely in earth where a wide side-hill cut would run into rock. Moreover, where the traffic is entirely in one direction, sharper curves can be safely used.

May it not be wise for American highway engineers to give consideration to the Italian design of mountain roads?

Let City Engineers Become "City Planners"

We are glad to note that the city of Rochester, N. Y., has secured an amendment to its charter providing that there shall be a City-Planning Bureau, the superintendent of which is to be appointed by and report to the City Engineer. His actions must be approved by an Advisory Board, who may be laymen, and by the Mayor.

City planning legislation has usually been defective in that it has failed to provide for a permanent organization with power to initiate and execute a continuous policy. A city engineer may not be "strong on" civic centers of Utopian beauty, but he is more apt to see to it that new streets are properly planned, old ones widened, traffic routed, obstructive ordinances revised—in short that the city shall gradually be made to improve systematically.

Prevent Failures of Sand-Clay Roads by Tamping

A good many sand-clay roads have badly disappointed their builders. When softened by rains before it has been compacted by traffic, a sand-clay road may become a quagmire. Both the mixing and the rolling of the sand and clay require far more attention than is commonly given.

Engineers who are seeking to inform themselves as to the best methods of mixing and compacting sand and clay will do well to study the method of building oiled earth roads with a rolling tamper—a roller with projecting lugs. The oil and earth are harrowed and a road grader is also used to mix them. Then the well-mixed mass is tamped solid with the "sheep's foot" roller.

Cost of State Aid Road Surveys in Illinois

By C. M. HATHAWAY

Assistant Road Engineer, Division of Highways, State Department of Public Works and Building.

The Illinois State Aid Road Law, passed in 1913, provides that all state aid money be allotted to the 102 counties (with one exception) in proportion to the county road and bridge tax of each, and that each county shall furnish a sum of money equal to the State allotment. The county may select the location of the roads for improvement and the types of construction, subject to the approval of the State Highway Commission. Not being limited as to the number of routes selected for improvement, the result is not only sections of work scattered among the several counties, but also often scattered in three or four remote sections of a county. The making of plans, estimates and specifications for all State aid improvement is in the hands of the State Highway Department and is handled directly by its own force.

Recently occasion arose to compile the cost of all State aid surveys covering the period from July 1, 1913, to Dec. 31, 1916. Since the surveys numbered over 400 and were made under conditions vastly different as to both location and topography, it was thought that the resulting figures offered an opportunity to present some authentic information which could be applied directly to Illinois, at least, and which might offer a basis of comparison and estimate for other localities, if due consideration was given to the various features involved.

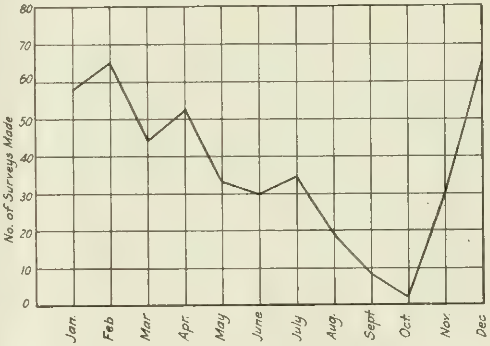


Fig. 1—Distribution of Road Surveys Throughout Year.

The information needed for making up State aid road plans requires that a survey of the proposed improvement be made with the usual detail and care that is necessary in making the ordinary road survey. This is essentially as follows: Location of a transit line which shall serve as a center line of the proposed improvement; location of all governing topographic features; complete cross sections usually at 100 ft. intervals; and all information governing drainage and gradients.

In nearly all cases the State Highway Department has kept the work of making surveys in its own hands, furnishing two men for the party and calling upon the County Superintendent of Highways to furnish the others, with the necessary transportation and supplies. (Since Jan. 1, 1917, the policy of the department has changed in that the entire cost of surveys is paid by the State Highway Department. The organization scheme has not been materially changed, however.) The two men from the department being thoroughly familiar with its practice give assurance that the desired information is gotten in the survey. A party of four to six men has been found to be the most efficient and economical for the work.

At first one might consider this to be a rather costly method of organizing and conducting a survey party, since each new party would consist of a new personnel, the men furnished by the county being more or less unfamiliar with survey work. However, inasmuch as the average length of the surveys was approximately only 2½ miles and nearly always there was lost considerable time in moving from one job to another, this method of handling the work has proved really more satisfactory than would have been the method of transporting from place to place a complete and fully organized survey party.

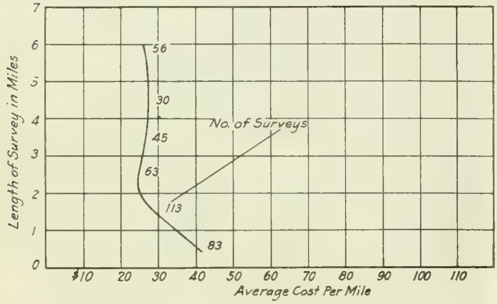


Fig. 2—Length of Survey and Cost Per Mile.

Many of the first surveys made were rather costly because of the lengths being so short and more time really being used in the work preliminary to starting the survey than in making the survey itself. In the earlier surveys a condition encountered was the getting of the county superintendents of highways and their assistants familiar with the methods of the work. As the practice went on, however, these men became very familiar with the methods and were ready to proceed with the work as soon as the men from the State Highway Department arrived at the site.

In verification of the above paragraph it was found that during 1914 the average cost per mile was $31.48 or about $5 higher than for the entire period.

The following figures have been deduced from the information as compiled:

Total number of surveys made	410.00
Total miles surveyed	1,090.71
Total cost of surveys	$28,791.00
Average cost per mile	$26.40
Average rate of survey per day ...mile	.82
Average length of surveys...miles	2.66

In the 410 surveys it was found that the average length was only a little over 2 miles, while 19 per cent were less than 1 mile in length. The encircled figures at the right of the curve in Fig. 2 show this feature.

To get the cost per day for the average survey party as employed for the State aid surveys, the following estimate may be of interest:

Two engineers from State Highway Department at $4	$ 8.00
Board and lodging for above at $2	4.00
Railroad fare (prorated), at 67 ct.	1.34
Three helpers at $2.50	7.50
Team or other conveyance at $3	3.00
Stakes, supplies, etc. (prorated) at $1	1.00
	$24.84

Approximately $25 for one day's work

In Fig. 1 is shown graphically the distribution of surveys throughout the year which brings out the fact that 53 per cent of all surveys were made during the period of Dec. 1-March 31, the coldest four months of the year and the ones least adapted for survey work.

In Fig. 2 is shown a curve platted on the basis of the cost per mile based on the length of each individual survey. The conclusion is self-evident and conforms to what might be expected.

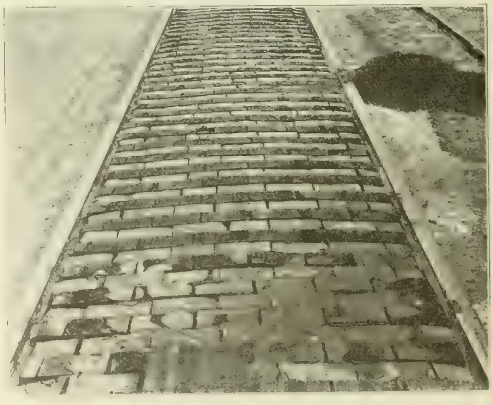
More detailed analysis of the subject has not been ventured, as it was hoped to furnish only a little information essentially covering cost per mile and rate of progress in making road surveys.

On July 1, 1917, the State Highway Department was merged with the Department of Public Works and Buildings and is known as the Division of Highways. S. E. Bradt is Superintendent of Highways and Wm. W. Marr, Chief Highway Engineer.

Alternate Rows of Wood Blocks and Bricks for Paving Street Railway Tracks

A new form of pavement for street railway tracks has been laid on Main St., Toledo, O., for the Toledo Railways & Light Co. On this work a 6-in. 100-lb. steel rail was used. A 2-in. header block was laid under the ball of the rail, to provide for the tread of the wheel flange. The pavement between the rails consists of alternate rows of Kreolite end lug wood blocks and ordinary second-hand paving bricks. The interstices between the individual units were filled with a Kreolite bituminous filler.

The blocks used on this work had been treated by the Rueping process with 6 lb. of creosote per cubic foot of timber. The blocks were laid about ⅛ in. higher than the adjoining rows of bricks, the idea being that the annealing effect of the traffic would weld the wood upon the edges, thus preventing the cobbling of the bricks.



Street Car Track Pavement Composed of Alternate Rows of Wood Blocks and Brick.

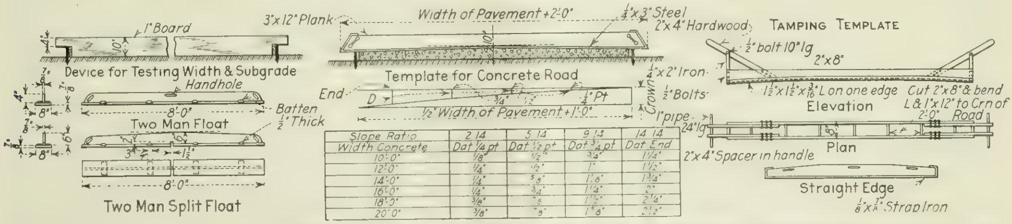
The pavement has been in service for over 6 months, and it is stated that the traffic has ironed it into a smooth, compact, homogenous-appearing wearing surface.

Concrete Pavement Specifications of Ohio State Highway Department

State highway construction in Ohio this season is being carried out under new specifications issued by Clinton Cowen, State Highway Commissioner. The requirements for concrete pavements are of especial interest.

The specifications provide that the ingredients of concrete shall be mixed in the proportion of 1 sack of cement to 1½ cu. ft. of fine aggregate and not more than 3 cu. ft. of coarse aggregate. The mortar shall always be more than enough to fill the voids in the coarse aggregate. If necessary to secure this result the proportion of coarse aggregate shall be reduced. In general, this will require from 7 to 8 sacks of cement per cubic yard of concrete, depending upon the class of aggregate used and the percentage of its voids.

It also is provided that the materials for the pavement shall be mixed with only sufficient water to produce a concrete which will settle very slowly when deposited in a pile and which will hold its shape when struck with a templet. The consistency shall not be such as to cause a separation of the mortar from the coarse aggregate when handling. After the concrete has been lightly tamped there shall be no free water in evidence. Individual particles of the coarse aggregate when isolated, shall show a coating of mortar containing its proportionate amount of sand.



Slope Ratio	2 14	5 14	9 14	14 14
Width Concrete	D at ¼ pt	D at ½ pt	D at ¾ pt	D at End
10'-0"	⅛"	½"	¾"	1¼"
12'-0"	¼"	½"	1"	1½"
14'-0"	¼"	⅝"	1⅛"	1¾"
16'-0"	¼"	¾"	1¼"	2"
18'-0"	⅜"	⅞"	1½"	2¼"
20'-0"	⅜"	⅞"	1⅝"	2½"

Designs of Templets, Floats, Etc., Suggested by Ohio State Highway Department as Meeting Its Requirements for Concrete Pavement Construction.

Regarding machine mixing the specifications state:

The concrete materials shall be measured in such a manner as to insure uniform proportioning of all of the ingredients The amount of water to be used for each batch shall be accurately measured by a suitable device attached to the mixer. In no case shall the mixer be loaded in excess of its rated capacity. After all of the materials have been placed in the drum of the mixer, the mixing shall continue at least one minute until the drum has made not less than 12 revolutions, at a speed of between 12 and 18 revolutions per minute, before any part of the batch is discharged.

Other interesting provisions of the specifications follow:

The concrete shall be deposited on the subgrade between the forms and shoveled into position in such quantity as to make a uniform layer about 1 in. greater than the required finished thickness. After being deposited between side forms, it shall be thoroughly spaded or rammed so as to produce uniform density and eliminate all voids. Concrete shall be deposited in successive batches and in a continuous operation between transverse joints. When the completion of a section extending between transverse joints is unavoidably interrupted, an intermediate transverse joint shall be placed at the point of stopping as hereinafter specified. Any concrete in excess of that needed to complete the section shall not be used in the work.

After being placed as above described, the concrete shall be struck off with a templet used as a cutting edge while moved with a combined longitudinal and cross-wise motion, leaving the surface of the concrete about ½ in. higher than the required finished surface. When used as a cutting edge there shall be in front of the templet at all times and over its entire length a slight but uniform excess of concrete which is pushed forward to where the new concrete is being deposited. After the concrete is thus struck off, it shall be consolidated and made uniformly dense by a succession of tamping motions with a heavy templet as the templet is slowly moved forward. After the concrete surface has been thoroughly tamped with the tamping templet, an accurate cutting templet shall be used to strike off the concrete to the exact height and true cross-section of the finished pavement.

When each templet is within 3 ft. of a transverse joint it shall be lifted to the joint, and the concrete leveled or compacted by moving the templet away from the joint. Any excess of concrete about the joint shall be removed. Any holes left by removing any material or device used in constructing a joint shall immediately be filled with concrete of the same proportions as the rest of the pavement. All concrete shall be dense in character, but special care must be exercised to secure maximum density adjoining transverse joints.

After being brought to the established grade by the use of templets as described above, the concrete shall be floated with a wooden float not less than 8 ft. long nor less than 6 in. wide, operated from two bridges with its axis approximately parallel to the center line of the pavement. This float shall be moved with a see-saw motion across the pavement with sufficient pressure being placed on same to eliminate any irregularities left in the concrete by the templet, and in a manner to thoroughly compact the concrete and produce a surface free from depressions or inequalities of any kind. The pavement shall be finished with a wooden float about 6 in. wide and 20 in. long; or, in lieu of this latter, a belt may be drawn back and forth across the pavement in such a way as to remove any collection of water on the surface and to leave the surface smooth, regular, and in conformity with the cross section required.

The concrete adjacent to the expansion joints shall be finished with a wooden float, which is divided through the center and which will permit the finishing on both sides of the filler at the same time, in such a way that it will produce the two edges at the same elevation. Both edges of the joints shall then be rounded off with an edger having a radius of ¼ in.

A finishing machine of approved type which will produce the above results may be used. The edges of the pavement shall be rounded with an edger to a radius of ¼ in.

The finished surface of the concrete shall conform so nearly to that indicated on the plans that it will nowhere vary more than a ¼ in. from the previously described templet or a 10-ft. straight edge applied to the surface of the concrete parallel to the center line of the pavement.

The specifications call for transverse joints ¼ in. in width, placed across the pavement perpendicular to the center line 50 ft. apart for plain concrete, and 100 ft. apart for reinforced concrete, unless it is otherwise shown on the plans. All joints must extend through the entire thickness of the pavement, and particular care must be taken to have the joint perpendicular to the surface.

As soon as a section of pavement has been finished, it must be entirely covered with canvas so supported as not to mar the pavement. As soon as the concrete has sufficiently hardened to prevent pitting, the surface of the pavement must be sprayed with water and kept wet until the earth covering has been placed. When the concrete has hardened to an extent that the surface of the pavement will not be marred by men walking upon it, it must be covered with not less than 2 in. of earth, or other suitable material, which covering must be immediately wet and must be kept wet for at least 10 days.

Widening Existing Streets to Meet Traffic Demands

An interesting discussion of the problems encountered in providing for increased traffic by widening existing streets was presented by Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment of New York City, in a paper read at the 9th National Conference on City Planning. In his paper, an abstract of which is given below, Mr. Lewis gives concrete examples of the methods employed by several cities for providing traffic thoroughfares:

New York affords some notable instances of roadway widening during the last few years. Perhaps the most conspicuous of these is that affecting 5th Ave. This street was laid out and acquired at a width of 100 ft. and was subdivided into a roadway of 40 ft. and sidewalks each 30 ft. wide. One-half of the sidewalk spaces had for many years been appropriated to private use. Many costly buildings had been erected, the entrances, steps and even supporting columns of which were within the street lines. In many instances fences had even been placed 15 ft. beyond the building lines and in the spaces enclosed by them there were sunken gardens and ornamental planting which added to the attractive appearance of the street. As the abutting property was gradually converted from residential to business use and as the traffic increased the roadway became inadequate, and it was decided that it should be increased from 40 to 55 ft. In order to compensate for the space thus taken from the sidewalks the removal of all encroachments beyond the street line was directed, although, in order to prevent the disfigurement of some very important and attractive buildings, it was agreed that owners who should, before a fixed date, remodel their buildings might retain such supporting columns or steps as would not encroach more than 2½ ft. beyond the building line. The entire expense of these changes had to be borne by the abutting owners. It has been estimated that the expense to the abutting owners aggregated about $2,000,000.

The widening of an existing street at a single operation is expensive, but occasionally it must be done. Relief for the congested condition of Broadway, New York, was imperatively necessary when in 1893 the municipal authorities decided that Elm St., now known as Lafayette St., parallel with and about 50 ft. east of Broadway, should be widened. The old street was from 50 to 60 ft. in width, and this was widened to 80 ft., and extended at the last named width as an entirely new street for a distance of over 3,000 ft. The entire length of the new thoroughfare thus created was about 6,000 ft. The total cost for the acquisition of property was approximately $5,500,000, two-thirds of which was borne by the city at large, and the remaining third was assessed upon an area of benefit about 3,000 ft. in width and 19,000 ft. in length, containing approximately 1,280 acres.

A more recent example of the widening of an existing street and its connection by means of a new street with an established thoroughfare is that of the widening of Varick St. and the southerly extension of 7th Ave. in the Borough of Manhattan. Varick St. was widened from 65 ft. to 100 ft., this last being the width of 7th Ave. and its extension. The total length of the widening was 3,700 ft. and of the extension 2,700 ft. It was authorized in 1913 and, while the total cost has not yet been finally determined, it will approximate $6,000,000, all of which is to be imposed upon a local area of benefit and upon three of the boroughs, no part being assumed by the city at large.

One more example from New York is that of Livingston St., in the Borough of Brooklyn. This street is parallel with Fulton St., the principal business street of the borough, and about 300 ft. distant from it. The most important retail shops of this borough run from Fulton St. through to Livingston St., and the latter, which was only 50 ft. wide, was so badly congested by the delivery wagons of these shops that it was useless for other purposes. It was widened to 80 ft. in 1905 for its entire length of about 4,300 ft. at a cost of a little over $2,000,000. A double track surface railway was constructed in it and it has been of incalculable benefit to this part of the city. It was proposed to assess one-third of the cost upon property deemed to be benefited, but mandatory legislation was secured relieving these property owners and imposing the entire cost upon the city.

Philadelphia also affords a number of instances of the widening of existing streets. Perhaps the most important undertaking of the kind has been the widening of Delaware Ave. along and in the vicinity of the Delaware River. This street will eventually extend from the Navy Yard on the south to Poquessing Creek on the north, a distance of about 17 miles. It was originally 50 ft. wide where in use, and the new width will vary from 100 to 250 ft. The improvement has already been carried out at a width of 150 ft. between Fairmount and Washington Aves., a distance of 2 miles, and between Dyott and Cumberland Sts., a distance of ⅓ mile. The widening to widths of from 150 to 250 ft. between Washington Ave. and Hoyt St., about 2¼ miles, is now in progress as a part of the South Philadelphia improvement. In portions of this street there are or will be from two to six steam railroad tracks. No estimate can be given of its total cost, but it has been financed from the proceeds of bond issues and without any local assessment.

A more modest improvement in Philadelphia is the widening of Oxford Ave. through the village of Fox Chase. This was originally a toll road, 50 ft. wide, and is occupied by a double track surface railroad. It has been widened to 70 ft. for a distance of about 1,200 ft. through the center of the village. Some of the buildings were rebuilt and others were moved back to the new street lines, the amount paid in damages being about $57,000.

Two instances of street widening are taken from Boston, the first being what is known as the Pleasant St. improvement. This consisted of a widening from about 40 ft. to 60 ft. for a distance of about 1,700 ft. The work was carried out under a special act of the legislature passed in 1911, and the assessments were limited to one-half the cost and the area of benefit to a distance of 125 ft. from the line of the improved street, or to the middle of the block. The total cost was about $681,000. About $137,000, or 20 per cent, was assessed.

Another Boston improvement which it may be proper to include, although its purpose was not so much to widen a street already congested with traffic as to substitute for a narrow alley a street which might accommodate traffic, is what is known as the Avery St. improvement. This consisted of a widening from about 16 ft. to 40 ft., and it was also done under a special act of the legislature, with the provision that the assessments should be limited to one-half of the expense. Although the improvement extended for a distance of only 400 ft., the cost was over $1,300,000, of which amount $601,000, or about 46 per cent, was assessed.

The method of establishing new building lines and progressively carrying out a widening has been used very infrequently in this country, although it is quite a common practice in European cities. Probably the best examples in this country are to be found in Philadelphia. A well-known instance is that of Chestnut St., formerly 50 ft. in width, which was widened to 60 ft. on the city plan by an ordinance adopted in 1884. It is a high-class retail shopping street and formerly had a roadway 26 ft. and sidewalks 12 ft. wide, the additional width being added to the sidewalks, the roadway remaining unchanged. Recent traffic counts showed about 4,600 vehicles passing a given point on this street between 5 a. m. and 9 p. m. The ordinance provided that after the adoption of the new lines no buildings should be erected or no buildings should be rebuilt or altered without being made to conform with the new lines. The improvement has been in progress for 33 years, and has been completed for the greater part of the distance. As buildings have been set back the owners have filed petitions for damages and in general awards have been allowed for ground taken where the abutting lots were reduced to a depth of 100 ft., but where a 100-ft. lot remained no awards have been allowed. Up to the present time the awards have reached a total of more than $500,000. Walnut St. and Arch St., between the Delaware and the Schuylkill Rivers, are both being widened in this same manner, the former from 50 to 60 ft. and the latter from 66 to 72 ft.

A few instances are to be found in this country of increasing the traffic capacity of a street by converting one or both of the sidewalks into roadway and placing new sidewalks in arcades under the buildings. Philadelphia again furnishes a notable example. Fifteenth St., between Market St. and South Penn Square, has a width of 50 ft., with a roadway of 26 ft. and sidewalks of 12 ft. each. The curb on the east side was set back 11 ft., or within 1 ft. of the street line, while a sidewalk 19 ft. in width was provided back of the new curb line and extending 18 ft. under the buildings. This improvement was also extended eastward along the north side of South Penn Square between 15th and Broad Sts. The arcade thus formed has been treated uniformly, the supporting piers are regularly spaced and all of the same size, and the results of this treatment have been very satisfactory, the shops fronting on the arcade appearing to be desirable, and they probably command good rentals. The total length of this arcade on both streets is 335 ft. and the cost to the city in damages paid for the easements and the reduction of available floor space in the buildings amounted to $193,000.

Where the rapid development of a particular district may be reasonably expected or where it is necessary to provide more adequate street capacity in order that traffic may be accommodated and suitable transit lines may be constructed within the streets at some time in the future and expensive widenings may be avoided, it is often necessary to lay out streets of generous width following the lines of existing roads which now serve as connections between centers of population, the importance of which will probably increase. An excellent illustration of such a widening is offered by Queens Boulevard in the City of New York. This boulevard follows streets which had already been laid out and acquired at widths varying from 60 to 100 ft. It extends from the Queensboro Bridge across the East River to Jamaica, a distance of approximately 7 miles. It bisects the greater portion of the Borough of Queens, and its future importance as a traffic artery is apparent. For about 6 of the 7 miles it was given the exceptional width of 200 ft. and for the remaining mile of 150 ft., the point of contraction corresponding with its junction with a proposed intersecting boulevard varying from 100 to 150 ft. in width. For the first mile the central portion of this street will be occupied by a three-track elevated rapid transit railroad built of concrete and of very attractive design. Beneath this will be located the surface railway tracks and there will be a wide traffic road on each side. The remainder of the boulevard, where the width is 200 ft., is to be divided into a central roadway of 44 ft., flanked on each side by park spaces of 30 ft., outside of which will be roadways 28 ft. in width, each one of which will accommodate a surface track railroad adjacent to the parked space. This generous width is, of course, designed not for present needs, but for those of the future, and, inasmuch as the abutting owners had already provided a street varying from 60 to 100 ft. in width, only 20 per cent of the cost of the acquisition of the land needed for the widening is to be assessed upon a zone extending 800 ft. on each side of the street, 30 per cent is to be imposed as a special tax on the Borough of Queens and the remaining 50 per cent is to be paid by the City of New York at large.

Another example is taken from Philadelphia, and is that of Moyamensing Ave. This street was widened from 50 ft. to 148 ft. for about ½ mile southwestwardly from Broad St. Its extension southwestwardly, however, will be affected by the widening of Penrose Ave. from 50 to 248 ft., and it is designed to furnish a direct through traffic route between Philadelphia and Chester. The section 148 ft. in width is subdivided into two 18-ft. sidewalks, two 26-ft. driveways and a central planting space 60 ft. in width. This space, however, may subsequently be used in whole or in part for the widening of the roadways, for surface railway tracks or for a high-speed elevated or subway transit line.

The plan of making future widenings possible and economical by the establishment of setback lines is relatively new in this country, although in some American cities there is a distinction between the street line and the building line. In most of our cities, however, these terms are considered to be synonymous.

Setback lines have actually been established in some of the smaller towns in this country. For example, in Winchester, Mass., building lines 20 ft. back of the street lines have been fixed for one street for a distance of ¾ mile. On the chief business street a setback of 15 ft. on both sides has been fixed for a distance of 1,000 ft., and on another main traffic artery setbacks of 20 ft. on both sides have been established for a distance of ½ mile, while in another case on a short section of a business street a setback of 10 ft. on one side and 12 ft. on the other has been prescribed.

The State Highway Department of Missouri in a recent bulletin suggests that mudholes sometimes can be remedied by drilling down 4 or 5 ft. and putting in a shot of dynamite to loosen the subsoil and provide underdrainage.

Platting Rules of City Plan Commission of Toledo, O.

The City Plan Commission of Toledo, O., has adopted a set of regulations governing the platting of property that will greatly facilitate the work of approving new plats. Any plat which conforms to the regulations may be approved by the Service Director without further action by the Board. The new rules follow:

Minimum Requirements for a Permanent Record.

Distances.—Lengths of all lot lines and overall distances around outside boundaries of plat to nearest 1/100 of a foot.

Angles—Angles of all outside corners of plat and sufficient angles to locate various interior points on plat.

Angles and tangent distances or center angles and degrees of curvature shall be given for curved streets or drives.

Monuments.—Not less than two granite, medina stone, or approved concrete monuments shall be located within the boundaries of simple rectangular plats. Sufficient additional stone or approved concrete monuments shall be placed on larger streets to locate all streets without difficulty.

Stakes.—Two-inch by 2-in. oak stakes shall be set on all lot corners. Gas pipe stakes are recommended for block corners.

General.—All plats to be furnished in duplicate on tracing cloth, 20x30-in. in size.

Plats must be drawn accurately to whatever scale is used.

Rights of way, granted for any purpose, shall be correctly shown. Building lines and regulations as required by the City Plan Commission shall be shown or recorded.

Names of proposed streets must not be the same as present names of streets or similar enough to cause undue confusion.

Two weeks shall be considered a reasonable minimum time for checking any plat.

(It is suggested that tentative paper drawings be submitted to the Commission before the finished tracings are made.)

Suggestions to Aid in Platting of Property.

Blocks.—In general 660 ft. shall be considered the unit block length. This may be varied to suit topographical conditions or to connect proposed to existing streets.

Streets.—The following shall be considered the minimum street widths:

	Feet.
Short drives or courts	50
Local streets	60
Through streets (not over ½ mile apart) and streets for car tracks	70

In general, however, existing streets shall be extended not less than their present width. Isolated plats shall have streets laid out to connect with future extensions of important streets, although these streets do not reach the plat at present.

Lots.—The minimum areas of lots of the cheapest class shall be approximately 3,500 sq. ft. The minimum depth of such lots shall be approximately 100 ft. or the minimum frontage 33 ft.

On boulevards, or in better class residence districts, this minimum may be increased or in business districts, etc., may be decreased to suit surrounding conditions.

Improvements.—Stone sidewalks, sanitary sewers and water supply shall be considered minimum improvements to be installed within a reasonable time, to be determined by the Commission as a condition of accepting the plat.

Street name posts with enameled steel name plates shall be installed at the time of the dedication of the plat.

Cost Data on Street Cleaning at Philadelphia

Interesting data on street cleaning costs at Philadelphia are contained in the last annual report of the Bureau of Highways. Special block tests on various types of pavements were made with machine brooms, the average costs being as follows:

	Per 1000 sq. yd., ct.
Granite Block	24.6
Brick	19.3
Wood block	16.6
Sheet asphalt	15.9
Average per all classes	22.6

The dirt removed per 1,000 sq. yd. of pavement was .158 cu. yd.; 98 gal. of water were used per 1,000 sq. yd. cleaned. On the regular work the average cost of street cleaning with machine brooms, based on the district reports, was 28.2 ct. per 1,000 sq. yd.

The unit costs per 1,000 sq. yd. of street cleaning by other methods were as follows:

	Squeegee		Flushing.	Hose Flushing.	Blockmen.
District. number.	Average from Block Tests.	Average from District Reports.	Average from District Reports.	Average from District Reports.	Average from District Reports.
1-A	$0.131	$0.223	......	......	$0.083
1-B	.174	.204	......	......	.081
2	.130	.196	.156	......	.179
3	.118	.094	.157	$0.474	.282
4-A	.176	.126	.174	......	.216
4-B	.115	.115	......	......	.140
5	.218	.192	.148	......	.111
6	.137	.182	.150	......	.174
Average	$0.148	$0.156	$0.157	$0.474	$0.152

The squeegee used 240 gal. of water per 1,000 sq. yd. cleaned and the flusher used 522 gal. The amount of dirt per 1,000 sq. yd. removed by the squeegee was 0.031 cu. yd.; the blockmen removed 0.051 cu. yd. per 1,000 sq. yd.

The squeegees were used on sheet asphalt and wood block streets only.

Flusher dirt was removed by blockmen.

The cost of labor and equipment per day was assumed as follows:

Superintendent	$ 4.00	Squeegee	$ 6.00
Foreman	2.50	Auto flusher	15.00
Gangmen	1.75	Dirt—	
Blockmen	1.50	Wagon	5.00
Dumpmen	1.50	Cart	3.50
Machine broom	5.50	Sprinkler	5.00

Output of Municipal Asphalt Plants, Chicago, Ill.—During 1916 the municipal asphalt plants of the Bureau of Streets of Chicago, Ill., turned out 19,238 tons of asphalt top and binder and 21,330 tons of asphaltic concrete. The detailed cost of this work, according to the last annual report of the Department of Public Works, was as follows:

	Total.	Per ton.
Asphalt Top:		
Material	$33,897	$3.6250
Labor	11,524	1.2324
Teams	10,860	1.1614
Totals	$56,281	$6.0188
Asphalt Binder:		
Material	$19,580	$1.9845
Labor	11,832	1.1992
Teams	11,478	1.633
Totals	$42,891	$4.3170
Asphaltic Concrete:		
Material	$56,541	$2.6507
Labor	19,152	.8979
Teams	14,526	.6810
Totals	$90,219	$4.2296

Comparative Cost of Guard Rail and Flat Side Slopes or Banquettes

By CHAS. R. THOMAS.

Assistant Engineer, Construction Service Co., New York.

A 1 to 4 slope on the sides of a fill or a banquette along the edge of the fill is cheaper than a 1½ to 1 slope with guard rail protection until a certain depth of fill is reached.

The sinking funds necessary to construct, maintain and reconstruct a linear foot of wood guard rail in Massachusetts as determined by J. A. Johnson, for many years a division engineer of the Massachusetts Highway Commission, are given in Table I. The table also gives the cubic yards of borrow at various costs per cubic yard that may be placed for the amount of the sinking fund.

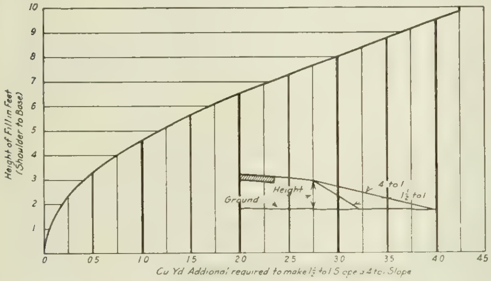


Fig. 1.

Figure 1 shows the cubic yards that must be added to a 1½ to 1 slope to make a 4 to 1 slope for various heights of fill. The ground is assumed to be level and the height of fill is the vertical distance from the outside edge of the shoulder to the base of the fill. Figure 2 gives similar information for two banquettes, the slopes being taken at 1½ to 1.

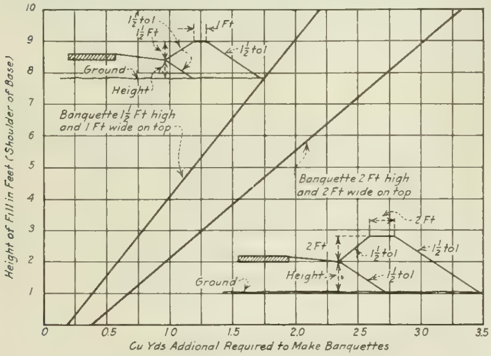


Fig. 2.

TABLE I.—COMPARATIVE COST OF GUARD RAIL AND FILL

(Cu. yds. of borrow that can be paid for by the sinking fund necessary to construct, maintain and reconstruct wood guard rail built at indicated unit prices.)

Guard rail per lin. ft.	Sinking fund required.	Borrow justifiable with excavation per cu. yd. at 20 ct.	30 ct	40 ct.	60 ct.	$1.00.	$1.40.
$0.15	$0.67	3.3	2.2	1.6	1.1	0.7	0.5
.20	.80	4.0	2.7	2.0	1.4	0.8	0.6
.25	1.00	5.0	3.4	2.5	1.7	1.0	0.7
.30	1.15	5.8	3.8	2.9	2.0	1.2	0.8
.35	1.35	6.8	4.5	3.4	2.2	1.4	1.0
.40	1.50	7.5	5.0	3.7	2.5	1.5	1.1
.45	1.65	8.2	5.5	4.1	2.7	1.7	1.1
.50	1.70	8.5	5.7	4.2	2.8	1.7	1.2

The economical height of fill at which the use of a guard rail is cheaper than a 4 to 1 slope or a banquette may be determined from the table and the curves.

For example, if guard rail costs 30 ct. per lineal foot of single rail and borrow (or excavation) 60 ct. per cubic yard it is seen from the table that 2 cu. yd. of borrow may be placed at the same ultimate cost as a lineal foot of wood guard rail.

From Fig. 1 it appears that the equivalent fill is 6.4 ft. high. Or fills up to 6.4 ft. in height may be given a 4 to 1 side slope for the same ultimate cost as a wood guard rail.

From Fig. 2 it appears that the equivalent fill for a banquette 2 ft. wide on top and 2 ft. high above the edge of the shoulder is 5.5 ft. high (shoulder to base). Or fills up to 5.5 ft. in height may be provided with a banquette for the same ultimate cost as a wood guard rail. Similarly fills 9 ft. high may be provided with a smaller banquette for the same ultimate cost.

Boxes on Motor Trucks Facilitate Handling of Road Materials

Boxes, each of 5 cu. ft. capacity, are used on motor trucks for hauling broken stone, sand, etc., at the U. S. Naval Station, Guam. This method of handling road building materials is described by Mr. G. S. Burrell, Civil Engineer, U. S. Navy, in the July Public Works of the Navy, from which the following note is taken:

There are in use at the station two 1½-ton gasoline motor trucks, which were delivered with express bodies. To haul cascajo (a partially decomposed coral) broken stone, sand, etc., with these trucks would ordinarily be rather expensive on account of the time lost in loading by shovel and the expense and time of shoveling out the load at point of delivery. In order to save both time and money, the sides have been temporarily lifted from the bodies of these trucks so as to permit of handling material in boxes. For each truck there have been constructed two sets of eight boxes each. The inside dimensions of the boxes are 1 ft. wide by 15 in. deep and 4 ft. long, making the capacity 5 cu. ft. each. The sides are extended to form handholds. The boxes are bound at ends and middle with galvanized-iron straps.

One set of boxes is filled at the point of loading, while the other set is in transit. As there are eight boxes to a load, 40 cu. ft. are carried at a time. On a 1-mile haul 22 round trips have been made by one truck in 7½ hours, thus delivering 33 cu. yd. of material and traveling 44 miles. On a 3-mile haul 14 round trips have been made in 7½ hours with the same sized load, making a total mileage of 84. The boxes serve equally well for road-building materials, broken stone, sand, and occasionally coal. They are proving of big advantage in the construction of the new radio station. Where practicable on road work a 2-yd. dump wagon is used as a trailer in addition to the box load carried on the truck itself.

The cost of constructing the boxes varies from $1 to $1.20 each, including both labor and material. The cost of a set is saved on one day's hauling if the haul is not over 1 mile in length. Under certain conditions it might be found advantageous to use a somewhat smaller box to make easier handling.

New Consistency Tester for Viscous Liquid Bituminous Materials

A new consistency tester for bituminous materials, having a wide range of usefulness, has been devised by Prevost Hubbard and F. P. Pritchard. This instrument was described by Messrs. Hubbard and Pritchard in a paper presented at the last annual meeting of the American Society for Testing Material, from which the matter following is taken.

The apparatus, details of which are shown in Fig. 1, was made at the U. S. Bureau of Standards. It is 3 in. long, weighs 2.8 g. in air and 1.487 g. in water, and has a specific gravity of 2.13. The circular aluminum disk A, 1.25 in. in diameter and 0.008 in. thick, is riveted to the middle of the aluminum rod B which is 0.625 in. in diameter. It is also riveted to the end of the hollow aluminum rod C, 0.25 in. in diameter and 1.3125 in. long. The upper end of rod C which is solid except for a hole large enough to allow entry of the small rod B is turned off to form a square shoulder. This end is passed through a snug-fitting hole in the center of the disk and is used to rivet the disk to the two rods at the shoulder. The disk carries two holes 0.04 in. in diameter, placed on opposite sides 0.145 in. from the center. The lower end of rod B is threaded and screws into the conical aluminum bottom weight D. The bottom weight has a 0.1875-in. taper running to the same diameter as rod C. Its upper end is turned off so as to fit snugly into the hollow end of rod C when it is screwed to rod B. The upper end of rod B carries two scale markings filled with red banking enamel, one 0.25 in. and the other 1.25 in. above the disk. The upper edges of these markings are exactly 1 in. apart. The instrument, which weighs normally 1.8 g., is filled with fine lead shot to a weight of exactly 2.8 g.

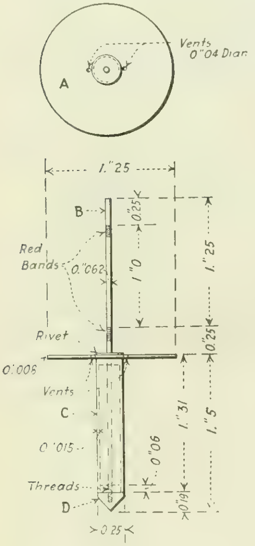


Fig. 1.

A special bitumen container is used with this instrument. It consists of a cylindrical flanged copper cup 2 in. in diameter and 3¾ in. deep, which is placed in a water-bath fitted with a stirrer passing through the flange of the cup. The flange is also provided with a small hole for the insertion of a thermometer in the bath.

Before making a test, the bituminous material, which fills the inner compartment of the water-bath, is brought to a temperature of exactly 25° C, which must also be maintained in the bath throughout the test. The surrounding atmosphere should also be as close to 25° C. as possible. When filling the container it is important that no air bubbles be imprisoned in the bituminous material, as they are apt to materially retard the passage of the instrument. Viscous materials should be warmed before pouring them into the container and should then be allowed to cool to 25° C. before making the test. If air or gas bubbles rise to the surface, they should be removed from time to time with a tiny flash point jet until the surface of the material remains perfectly smooth.

The test is made by allowing the instrument to sink of its own weight in the bituminous material from the upper edge of the lower scale marking to that of the upper marking, and noting the time required. When placing the instrument in the material, the disk should first strike it at an angle and then be permitted to settle until it lies flat. This precaution eliminates the chance of imprisoning air under the disk. In the case of very viscous materials, when it is necessary to push the disk below the surface, the top of the lower scale marking should never be lower than the general level of the material in the container, when the actual test is started. Any surface deformation due to such procedure should first be allowed to correct itself. After a test has been made the instrument should be removed and allowed to drain. It should then be immersed in a beaker of solvent for a few minutes and then carefully dried. Gas holder oil, carbon disulfide or solvent naphtha will be found convenient for use as a cleaning solvent. If the material is very viscous, the instrument may be allowed to drain in an oven at about 100° C. for a few minutes before immersing it in the solvent. As it is made of aluminum it should of course never be heated in a free flame.

This instrument was found to have a wide range of usefulness. At normal temperatures it may be used for all bituminous materials outside of the range of the Engler viscosimeter and the usual penetration machine. When used in connection with a representative set of commercial bituminous road materials, it was found that comparatively few materials whose penetration at 25° C. could not be ascertained required more than 30 minutes for a test with the new instrument. In fact, most of the material prepared for hot-surface treatment, showed a test of less than 15 minutes.

Comparative Costs of Street Sprinkling with Motor Trucks and Horse Drawn Tanks

A recent report of the Board of Public Works of Los Angeles, Cal., gives the comparative costs of street sprinkling with motor-driven sprinklers and with team-hauled tanks.

Savings in money and water, more efficient sprinkling and relief of traffic conditions were among the benefits reported after a year's use of the motor-driven trucks as shown by the following table:

Teams:	
Total team days of 8 hours each	10,910
Loads of water used, 550 gal. per load	303,722
Average loads of water used per day (per team)	*27.8
Miles of streets sprinkled	47,209.7
Miles of streets sprinkled per day, average (per team)	4.33
Cost for team hire	$51,301.16
Cost for team hire per mile of street sprinkled	$1.087
Motor Sprinkling:	
Total truck days of 8 hours each	1,178.25
Loads of water used, 1,200 gal. per load	49,618
Average loads of water used per day (per truck)	†42.11
Miles of streets sprinkled	20,303.38
Miles of streets sprinkled per day, average (per truck)	17.23
Cost for truck hire	$17,519.98
Cost for truck hire per mile of street sprinkled	$0.863

*This is a rate of a load in 17 min. for the team tank, sprinkling 820 ft. of street.

†This is a rate of a load in 11 min. for the truck tank, sprinkling 2,170 ft. of street.

Gravel Plant Transported from Job to Job by Motor Trucks

A portable gravel plant capable of producing 200 cu. yd. of road material per day is being used on highway construction for Kane County, Illinois. The outfit consists of a crusher, screen, elevator and bin. Power for operating the plant is supplied by a gasoline tractor. The bin has a capacity of 15 cu. yd. and is so built that it can be easily transported on a motor truck. The screen is mounted on a trailer. The material is brought to the plant by teams and scrapers and is separated by the screen before it is crushed. Both the crushed gravel and the finer gravel are deposited in the bins by the same elevator.

The lower part of the supports of the bin are detachable. In moving from one job to another the lower ends of the posts and the sills are removed and the bin body lowered upon a motor truck. The outfit in traveling order is shown in one of the accompanying illustrations.

Gravel Plant En Route to New Job.

Kane County Gravel Plant in Operation.

The plant was designed by Mr. George N. Lamb, County Superintendent of Highways.

Maintenance Costs of Pavements in Chicago.—Approximately $442,000 were expended in 1916 by the Bureau of Streets of Chicago, Ill., for repairs to pavements. The following table from the last annual report of the Department of Public Works shows the cost of repairing the various types:

	Asphalt.	Brick.	Creosoted block.	Granite block.	Macadam.
Sq. yds. maintenance	9,497,117	2,040,327	213,700	1,599,829	10,689,000
Sq. yds. repaired	144,280	49,714	6,907	73,732	763,497
Total cost	$155,406	$57,799	$10,940	$44,881	$172,942
Repair cost per sq. yd.	$1.0771	$1.1626	$1.5847	$0.6087	$0.2265
Maintenance cost per sq. yd.	$0.0163	$0.0283	$0.0512	$0.0280	$0.0161

The operating cost during July of the 14 automobiles owned by the city of San Diego, Cal., was 4.3 ct. per mile. This cost includes all shop repairs, tires, tubes, fuel and oil. The machines covered 17,282 miles.

The average cost of street cleaning at San Diego, Cal., with vacuum cleaners for the first 7 months of this year was 18.397 ct. per 1,000 sq. yd. for machine No. 1, and 10.69 ct. for machine No. 2.

Bituminous Surfaces for Macadam Roads*

While a number of failures in the use of surface treatments of bituminous materials have been due to the use of unsuitable materials, a greater number of poor results can be attributed to carelessness and lack of knowledge in connection with the methods of application. A good material will seldom if ever produce the desired results with improper handling, while a material of inferior quality, if carefully and properly used, will in many cases give fair service. The strictest adherence to the principles involved in the application of these materials is necessary if success is to be attained in their use.

Cold Surface Treatments.—In the case of newly built macadam roads it is not advisable to apply the bituminous material immediately following the completion of construction. The reason for this is the fact that for the proper bonding of the macadam a certain amount of moisture is necessary, and that the covering of the surface with a waterproof material prevents moisture from being absorbed into the surface and forming the required bond. While the water applied during the final stages of construction is essential, a new road derives great benefit from occasional showers of rain and moisture absorbed from the atmosphere.

While it is impossible to set forth any definite rule, no two sets of conditions being the same, it is generally understood that the macadam road should have carried traffic for at least one month prior to the application of even a cold surface treatment. This gives the bond in the road time to set up, and any settlement in the surface will become apparent and can be rectified before the oil or tar is applied.

The fact that the road is eventually to be treated does not relieve the superintendent or foreman from any responsibility in connection with the details of construction. It is an infallible rule that the better the road is built the greater will be the effects of bituminous applications. The assumption that the material to be applied will aid in the bonding of the road surface is a forerunner of failure, as experience has proved. Nor will the application of these materials be effective in the case of an old road unless the surface is in a proper state of repair. The time to fill ruts and depressions is before the bituminous treatment, not afterwards.

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*From a manual issued July 1 by the Department of Public Highways of Ontario, Canada.

A clean surface is essential; tar or oil applied to the road over a layer of dust and dirt is wasted and occasions discomfort instead of comfort to the traveling public. Surface treatments are for the prevention of the formation of dust as well as for the prevention of its removal from the road. Consequently, if the material is applied to a dusty road, it is impossible for it to come in contact with the hard surface and its effect is almost entirely lost.

If the road to be treated is wide enough for two lines of traffic, one half should be closed and signs posted stating that the road is being oiled and instructing traffic to proceed with caution. In the case of narrow roads they should be entirely closed to traffic for short stretches at a time and provision made for detours. It is impossible to properly apply bituminous materials on a road that is carrying traffic.

Providing the surface requires no repairs, or that these have been made, the road should be thoroughly swept. This does not mean a light sweeping with hand brooms, which removes the loose dust only, but a thorough cleaning, which removes not only the loose material from the surface, but also the dust and binder from around the top of the stone in the surface. Stiff stable brooms can be used, but better results will attend the use of a horse-drawn street sweeper with a revolving brush. One sweeping should not be considered sufficient, but the operation should be repeated until the mosaic on the surface stands out clean and clear. Not till then is the surface ready for the tar or oil.

The materials usually come in tank cars of from 6,000 to 8,000 gal. capacity, except in the case of small shipments, when the material is put up in barrels or steel drums. In the majority of cases tank car shipments are made.

In applying fluid bituminous materials a distributor wagon should be used; a water sprinkling tank is suitable, but will have to be fitted with a spraying attachment with a control valve and openings of sufficient size to allow the uniform distribution of the material in desired quantity. The length of the distributor should be sufficient to cover the entire surface in the case of very narrow roads, or shorter, in order that the application can be made in two or more strips on wide roads. There should not, however, be any part of the surface uncovered, and the distributor should always travel in one direction.

The applications should be made during warm weather, when the road is thoroughly dry and there is no indication of rain. While warm the material will spread more uniformly, and in the absence of moisture will penetrate and adhere more strongly to the road surface.

The quantity of material applied will depend on the grade used and the condition of the surface. From 1/5 to ¼ Imp. gal. per square yard is the usual amount. A stretch of road should be measured, the area calculated, and the valve on the distributor regulated till the desired application is obtained. Experience is the best guide in this matter.

The advisability of applying a coating of clean sand or fine gravel will also depend on the conditions mentioned above. With some materials it has not been found necessary; with others it is required, in order to prevent the material adhering to the tires of the vehicles. Where it is applied, a period of several hours should elapse between the application of the oil or tar and the spreading of the sand, in order that the bituminous material may spread over and penetrate the road and "seal up." The sand when applied will then absorb any excess material and permit the road being opened to traffic earlier than when it is not used.

Hot Surface Treatments.—The principles governing the successful use of materials for cold surface treatments are the same when the materials used are of such consistency that they require preheating. The chief difference is in the method of application.

Where small stretches of road are to be treated the material may be applied by hand. It will usually be shipped in drums or barrels and can be heated in small portable heating kettles, of which there are a number of types, and applied with hand sprinklers. Usually, however, the work is of such a size that tank car quantities are purchased and distributing wagons used. In this case it is advisable that the material be applied under pressure, as by this means a greater bond with the surface of the road is obtained and the scrubbing action of the spray cleans the minute particles of dust, which it is impossible to remove otherwise, from the road.

The tank cars in which hot application materials are shipped are fitted with interior steam coils in order that the material may be heated quickly. It will be necessary to provide a small steam boiler, of approximately 20 H.P. capacity, at the siding and connect it to the heating coils of the car. The length of time required to render the material sufficiently fluid to be transferred to the distributing wagon is approximately 48 hours, the transfer of the material to the distributor being accomplished by applying steam pressure to the top of the tank and attaching a pipe from the bottom of the tank to the distributor.

Distributing wagons are self-propelled or are designed to be drawn by the roller and are provided with heating coils to which the boiler of the roller is connected. This keeps the material hot and at the same time steam is utilized to secure the desired pressure at the nozzles.

The distributing arrangement may be in the form of nozzles which are controlled by valves, and apply the material in the form of fan-like jets, an ordinary sprinkler, or a hose with a nozzle may be attached to the distributing wagon and guided by hand. In each case skill and experience are necessary to obtain the proper application.

The quantity used in hot surface treatments may vary from ¼ to ½ Imp. gal. per square yard of surface. The grade of material used, the condition of the road and the thickness of carpet desired will govern this.

Shortly after the application of the material, as soon as it has had time to "seal up," the surface should be covered with a layer of pea gravel, clean stone screenings or very coarse, clean sand. This should be applied in small quantities and spread uniformly, an excess being avoided. The result should be a thin mat or carpet on the surface, composed of the bituminous material and the fine aggregate.

A thick bituminous coat is not desirable, as experience has shown that it will not adhere uniformly to the surface and will wave and shove under traffic. Better practice recommends successive applications in small quantities, which results in retaining on the surface of the road a thin, tough, impregnated film.

Surface Binders—Penetration Method.—A bituminous surface, constructed by the penetration method, may be laid either on a new foundation or on an old macadam road, the traffic on which demands a surface of this type. In the case of a road which has been under traffic for a number of years, with resulting ruts and depressions, the surface should be lightly scarified; with the grading machine the contour should be reformed; new stone or gravel applied; and rolling continued until an even, dense surface is obtained. On such a foundation a new wearing course, carefully constructed, will give excellent service.

Crushed stone of a size commonly known as "2-in.," but which should be more definitely specified as material all of which will pass a 2¾-in. circular opening and be retained by a 1½-in. circular opening, should be used for the surface. The compacted depth of the surface course should be, in general, 3 in., but, as circumstances will decide, a greater depth may be advisable. The minimum depth, however, should not be less than 3 in. The material should be spread on the surface of the foundation evenly and well compacted with a roller weighing at least 10 tons. All unevenness and depressions should be eliminated and the surface brought to an even grade and crown. It is then ready for the application of the bituminous binder.

Binders are solid at ordinary temperatures and will, therefore, require heating before they can be handled. They will be shipped in tank cars fitted with internal heating coils, and should be heated in the same manner as hot surfacing materials. The temperature to which asphaltic binders should be heated is between 200 and 300° F. and that for tar binders should be lower, between 200 and 250° F. The upper limit of temperature should not be exceeded, as there is danger of injuring the material when this is done.

In order to obtain a penetration to as great a depth as possible a pressure distributor should be used, pressure being obtained by means of a pump, in the case of self-contained distributors, or by steam when a distributing wagon is drawn behind the roller. Pressures used will vary with the type of distributor, but should be in the neighborhood of 50 lb. per square inch.

When it is necessary to apply the material in successive strips great care must be taken that the strips do not overlap to any great extent, as an excess of material will form a narrow ridge in the center. On the other hand, there should not be a strip of the surface which has not received the proper amount of material. A method which has been used with success to avoid these two objectionable conditions consists of laying a strip of heavy building paper at the edge of the first application and overlapping with the second application. The paper is then removed and destroyed.

The amount of material which should be applied will be in proportion to the thickness of the surface. For a compacted surface 3 in. thick the amount of bituminous material required to fill the voids is approximately 1½ Imp. gal. per square yard of surface. When the course is greater than 3 in. in thickness the amount of binder should be increased in proportion.

This should be followed by a thin layer of clean, crushed stone, all of which passes a 1½-in. circular opening and is retained by a ¾-in. or ⅝-in. circular opening. It should be spread uniformly and rolled with a 10-ton roller until it is thoroughly compacted, fills the voids in the larger stone, and the surface is even and true to grade and crown.

In some instances a seal coat of material, at the rate of ¼ to ½ Imp. gal. per square yard, is used, being applied after the small stone has been rolled and all the loose material swept off the surface. The use of a seal coat is, however, not universal, and the question of its application should be decided by the engineer or superintendent.

Economical Proportions for Portland Cement Mortars and Concretes

In a paper presented at the last annual meeting of the American Society for Testing Materials, Mr. J. A. Kitts submitted some interesting data on the limits of economical proportions for mortars and concretes. His paper, an abstract of which is given below, was based on the theory that the maximum efficiency proportion for a mortar or a concrete is controlled largely by the proportions of voids in the respective aggregates:

Mortars.

A mortar is a mixture of sand, cement and water in various proportions. The question of scientific interest is: What determines the mixture of maximum efficiency?

Sands vary in physical, chemical and mechanical structure, causing a variation in the specific gravity and percentage of voids, and these latter cause a variation in the weight per cubic foot or aggregate specific gravity. An important consideration in the study of a large number of mortars from a large number of aggregates is that of comparison. A study of the characteristics of various sands will show that mortars are not comparable either in arbitrary weight proportions or in arbitrary volumetric proportions. What, then, determines the conditions for comparison of the mortar from one sand with that of another?

An analysis of the results indicated in Prof. M. O. Withey's tests of mortars[1] throws considerable light on the two preceding questions. In these tests mortars were made in 1:2, 1:3, 1:4 and 1:5 weight proportions and the following tests made: Unit tensile strength; unit compressive strength; leakage of water through specimens 2 in. thick with pressures of 10 and 40 lb. per square inch; density; yield; and compressive strength in proportion to cost. Tables I and II show the physical and mechanical characteristics of eleven of the sands used in these tests.

Tables III and IV show the variations of the volumetric and void conditions common to simple weight proportioning.

Table III is computed by the following equation:

$$\frac{\text{Agg. Volume Sand}}{\text{Agg. Volume Cement}} = \frac{\text{Wt. Proportion Sand}}{\text{Wt. Proportion Cement}} \times \frac{\text{Agg. Sp. Gr. Cement}}{\text{Agg. Sp. Gr. Sand}}. \quad (1)$$

$$\text{Aggregate Specific Gravity} = (1 - \text{Proportion of Voids}) \times \text{Specific Gravity}. \quad (2)$$

$$= \frac{\text{Weight, in lb. per cu. ft.}}{62.5}$$

$$= 110/62.5 = 1.76 \text{ for cement.}^{2}$$

Table IV is computed by the following equation:

$$\frac{\text{Vol. of Cement Paste}}{\text{Vol. of Voids in Sand}} = \frac{\text{Agg. Sp. Gr. of Sand}}{\text{Agg. Sp. Gr. of Cement} \times \text{Wt. Proportion of Sand} \times \text{Voids in Sand}} \quad (3)$$

Table III shows that the volumetric proportions corresponding to the 1:2 weight proportions vary from 1:1.77 to 1:2.41, the 1:3 weight from 1:2.65 to 1:3.62 volume, 1:4 weight from 1:3.54 to 1:4.82 volume, and the 1:5 from 1:4.42 to 1:6.03. Table IV shows the proportions of voids in the sands filled with cement paste varying from 0.91 to 2.03 for the 1:2 weight proportion, from 0.61 to 1.35 for the 1:3, from 0.46 to 1.01 for the 1:4, and from 0.37 to 0.81 for the 1:5 proportion. Nothing could better illustrate the fallacy of the practice of comparing work sands with standard sand in 1:3 weight proportions.

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[1] M. O. Withey, "Tests of Mortars Made from Wisconsin Aggregates," Proceedings, Am. Soc. Test. Mats., Vol. XIII, p. 834 (1913).

[2] 110 lb. of cement makes 1 cu. ft. of normal-consistency paste.

Neither is there a basis of comparison in a fixed volumetric proportion. In 1:3 volumetric proportions the proportions of the voids in the sands filled with cement paste would vary from 0.73 to 1.20 for the 11 sands, as shown in Table V. It must be admitted, from a scientific or practical consideration of a mortar, that a very important function of the cement is to fill the voids in the sand; and it cannot be expected that a mortar in which the volume of cement paste is equal to only 73 per cent of the volume of voids in the sand is comparable with that in which the cement paste is equal to 120 per cent of the voids.

Assume, for example, that six mortars of a certain sand and cement are made in which the ratio of the volume of cement paste to the volume of voids in the sand has, respectively, the values of 0.50, 0.75, 1.00, 1.50, 2.00 and 3.00. It is reasonable to anticipate that the strength of the mortars will increase at a rapid rate until the voids in the sand are filled with cement paste, after which the strength will increase at a lesser rate until the sand particles are so widely separated by the cement paste that the strength of the mortar will closely approximate the strength of the neat cement. In other words, as the cement content is increased, the rate of increase of strength is greater before the voids are filled than it is after the voids are filled, and in some finite proportions the strength of the mortar approximates the strength of the neat cement. Fig. 1, which shows the compressive and tensile strengths and the strength in proportion to cost for sand No. 10, plotted against the void-filled ratio, illustrates these assumptions very well. This sand, unfortunately, is the only one of this series of tests which has a proportion (1:4 by weight) closely equal to that in which the volume of cement paste is equal to the volume of voids in the sand, and which has more than one proportion in which the volume of cement paste is greater than the volume of voids in the sand.

TABLE I.—PROPERTIES OF SANDS. (FROM WITHEY'S TABLE I.)

Sand. No.	Weight per cubic foot, lb.	Specific Gravity.	Voids, per cent.	Silt, per cent.	Absorption, per cent.
Standard	104.1	2.65	37.0	...	....
Sd. 1	105.2	2.66	36.5	3.0	0.19
Sd. 2	106.9	2.74	35.2	1.3	0.49
Sd. 3	101.8	2.68	38.2	0.8	0.27
Sd. 4	98.9	2.63	39.8	1.2	0.04
Sd. 5	91.2	2.67	45.3	0.5	0.17
Sd. 7	105.2	2.78	36.6	1.6	0.41
Sd. 8	105.3	2.70	36.4	1.5	0.18
Sd. 9	105.5	2.75	36.0	0.7	0.51
Sd 10	120.3	2.77	27.9	7.7	0.29
Sd. 11	108.7	2.72	35.0	0.4	0.11

TABLE II.—SIEVE ANALYSIS OF SANDS. (FROM WITHEY'S TABLE II.)

Sand No	Percentage by Weight Passing Sieves Nos. 10	20	30	40	50	74	100	Uniformity Coefficient
Standard	100.0	100.0	0.0	....	....	....	....	....
Sd 1	86.4	65.5	50.0	25.0	9.1	5.4	2.8	3.0
Sd 2	81.2	70.9	61.4	52.4	34.5	17.9	9.7	2.6
Sd. 3	91.9	72.7	39.7	26.4	13.7	4.2	1.2	2.4
Sd. 4	100.0	99.5	95.8	88.8	62.5	22.1	8.6	1.8
Sd. 5	100.0	99.9	99.8	99.1	67.6	18.2	5.7	1.8
Sd. 7	67.7	44.5	25.9	17.8	11.2	3.8	2.2	4.7
Sd. 8	82.0	72.5	55.1	38.6	16.1	3.6	1.5	2.6
Sd. 9	66.8	22.7	13.9	10.3	4.9	2.4	1.4	3.7
Sd. 10	59.7	48.8	34.0	26.3	17.4	8.7	6.5	6.9
Sd. 11	72.0	47.7	23.8	12.0	4.3	0.7	0.5	3.4

TABLE III.—VOLUMETRIC PROPORTIONS FOR SIMPLE WEIGHT PROPORTIONS.

Sand No.	Weight Proportions. 1:2	1:3	1:4	1:5
Sd. 10	1:1.77	1:2.65	1:3.54	1:4.42
Sd. 2	1:1.98	1:2.97	1:3.96	1:4.94
Sd. 11	1:1.99	1:2.98	1:3.97	1:4.97
Sd. 7	1:2	1:3	1:4	1:5
Sd. 9	1:2	1:3	1:4	1:5
Sd. 8	1:2.05	1:3.07	1:4.10	1:5.12
Sd 1	1:2.08	1:3.12	1:4.17	1:5.20
Standard	1:2.11	1:3.17	1:4.22	1:5.27
Sd. 3	1:2.13	1:3.20	1:4.27	1:5.33
Sd 4	1:2.23	1:3.34	1:4.46	1:5.57
Sd 5	1:2.41	1:3.62	1:4.82	1:6.03

TABLE IV.—RATIO OF VOLUME OF CEMENT PASTE TO VOLUME OF VOIDS IN SAND FOR SIMPLE WEIGHT PROPORTIONS.

Sand No	Weight Proportions. 1:2	1:3	1:4	1:5
Sd. 10	2.03	1.35	1.01	0.81
Sd 11	1.44	0.96	0.72	0.58
Sd 2	1.43	0.96	0.72	0.57
Sd 9	1.39	0.93	0.70	0.56
Sd 7	1.37	0.91	0.68	0.55
Sd. 8	1.34	0.90	0.67	0.54
Sd. 1	1.32	0.87	0.66	0.53
Standard	1.28	0.85	0.64	0.51
Sd. 3	1.23	0.82	0.61	0.49
Sd 4	1.13	0.75	0.56	0.45
Sd. 5	0.91	0.61	0.46	0.37

TABLE V.—RATIO OF VOLUME OF CEMENT PASTE TO VOLUME OF VOIDS IN SAND, FOR SIMPLE VOLUMETRIC PROPORTIONS.

Sand No.	Volumetric Proportions 1:2	1:3	1:4	1:5
Sd. 5	1.10	0.73	0.55	0.44
Sd. 4	1.25	0.84	0.63	0.50
Sd. 3	1.31	0.87	0.65	0.51
Standard	1.35	0.90	0.68	0.54
Sd. 7	1.35	0.91	0.68	0.55
Sd. 1	1.36	0.91	0.68	0.55
Sd. 8	1.37	0.92	0.69	0.56
Sd. 9	1.39	0.93	0.69	0.56
Sd 2	1.42	0.95	0.71	0.57
Sd. 11	1.43	0.95	0.71	0.57
Sd 10	1.79	1.20	0.90	0.72

$$\frac{\text{Volume of Cement Paste}}{\text{Volume of Voids in Sand}} = \frac{1}{\text{Vol. Prop. of Sand} \times \text{Prop. of Voids in Sand}} \qquad (4)$$

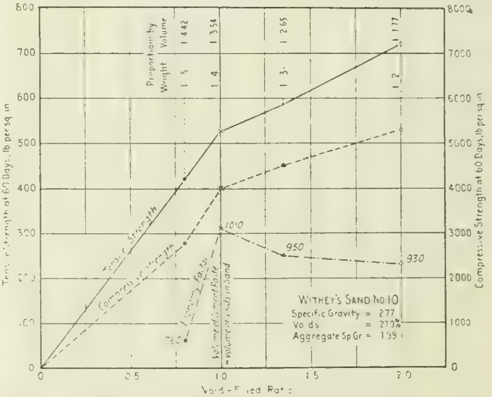

Fig. 1—Variation in Strength of Mortar from Sand No. 10 in Proportion to Void Filled Ratios.

Fig. 2 shows the compressive strengths plotted against the void-filled ratio. The curve of averages supports the assumption as to the rate of increase of strength. The curve of averages is fairly uniform, and would appear to indicate that the void-filled ratio has a similar effect on all the sands. This, then, appears to establish the principle that the properties, strength, efficiency, etc., of mortars are properly compared on the basis of the void-filled ratio.

The final and most important consideration of a mortar is the strength in proportion to the cost. This may be expressed as an "economy factor," equal to the compressive strength in pounds per square inch divided by the cost of the mortar in dollars per cubic yard. This factor may be expressed by the following equation:

$$\text{Economy Factor} = \frac{\text{Compressive Strength (lb. per sq. in.)}}{\text{Cost of Mortar (dollars per cu. yd.)}} = \frac{\text{Compressive Strength} \times \text{Yield}}{C_s + \frac{P_c X C_c}{P_s}} \qquad (5)$$

in which P_c and P_s are the volumetric proportions of cement and sand, C_c and C_s are the costs, in dollars per cubic yard, of cement and sand, and the yield is based on the volume of the sand as unity.

This factor is plotted in Fig. 10 of Withey's paper, previously referred to. The cost represents cost of materials only, cement being estimated at \$1.50 per barrel and sand at \$1.25 per cubic yard. In Fig. 3 these factors for all 11 sands have been plotted against the void-filled ratio. The average compressive strength of the cement used in these tests was less than 7,000 lb. per square inch at 60 days. The economy factor for the neat cement mortar would then be approximately $7,000 \div 10.14 = 690$[3]. The highest economy factor shown on the curve of averages is 860. This and the curve of averages indicate that the economy factor decreases when the void-filled ratio is somewhat in excess of 1.5. The results of these tests, therefore, indicate that the most economical mixtures lie between proportions giving a void-filled ratio from 1 to 1.5.

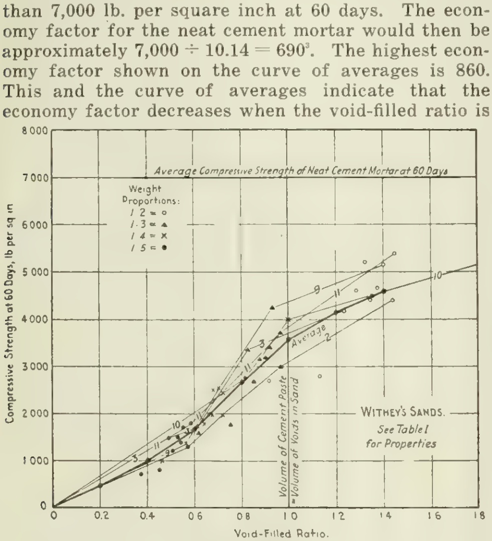

Fig. 2—Variation in Strength of Mortars in Proportion to Void Filled Ratios.

As an illustration, Fig. 3 shows that the most economical proportion for sand No. 10 is that in which the volume of cement paste is equal to the volume of voids. From Fig. 1, it is seen that this proportion is 1 cement : 3.58 sand by volume, giving a tensile strength at 60 days of 525 lb. per square inch, a compressive strength of 4,000 lb. per square inch, and an economy factor slightly over 1,000.

The equations for economical mixtures, as indicated by this series of tests, may therefore be written:

$$\frac{\text{Volume of Sand}}{\text{Volume of Cement}} = \frac{1}{(1 \text{ to } 1.5) \times \text{Proportion of Voids in Sand}} \quad (6)$$

$$\frac{\text{Weight of Sand}}{\text{Weight of Cement}} = \frac{\text{Agg. Sp. Gr. of Sand}}{(1 \text{ to } 1.5) \times \text{Agg. Sp. Gr. of Cement} \times \text{Voids in Sand}} \quad \ldots.(7)$$

If the properties of mortars from all sands vary with the variation of the void-filled ratio, the leakage, density and yield should show similar effects for all sands. Fig. 4 shows the leakage of the various mortars plotted against the void-filled ratio; and this is another proof that the void-filled ratio is the proper basis of comparison of the properties of mortars.

Conclusions Regarding Mortars.

1. Sand-cement mortars are not comparable in simple weight proportions because of the wide variations in the corresponding volumetric proportions and the variations of the void-filled ratios.

2. Sand-cement mortars are not comparable in simple volumetric proportions because of the wide variations of the void-filled ratios.

3. The void-filled ratio has a general effect upon the strength, permeability and economy of a mortar and undoubtedly affects the density and yield.

4. An important function of the cement paste is to fill the voids in the sand.

5. Sand-cement mortars are properly comparable on the basis of the void-filled ratios.

6. The economical proportions for sand-cement mortars depend upon the void contents of the sands and may be expressed by Eqs. 6 and 7.

7. The economy factor expresses the relative efficiency of mortars and may be determined by Eq. 5.

8. The writer finds no general relation of silt content, uniformity coefficient, and absorption to the efficiency of sands.

Concrete.

In the case where concrete is made from the bank run of gravel, or a concrete mix, and cement, it would be reasonable to expect the same general principles to apply as previously stated for mortars. Where mortar is added to a coarse aggregate, such as rock, it is reasonable to assume that an important function of the mortar is to fill the voids in the rock.

A scientific test to determine the laws of concrete mixtures would be, first, to determine the mortar of maximum density and the yield of mortar; second, to make progressive proportions of the mortar with the rock, using values of the ratio of the volume of mortar to the volume of voids in rock equal to 0.50, 0.75, 0.90, 1.00, 1.10, 1.25, 1.50, 2.00 and 3.00, with a view of determining that proportion giving maximum efficiency; and, finally, to make additional progressive proportions, maintaining the ratio of fine to coarse aggregate of the "efficient" proportion just determined, but increasing the amount of cement to 1.1, 1.2, 1.3, 1.4, 1.5, 2.0 and 3.0 times that used in the mortar of maximum density. The most economical proportions would be determined by the following equation:

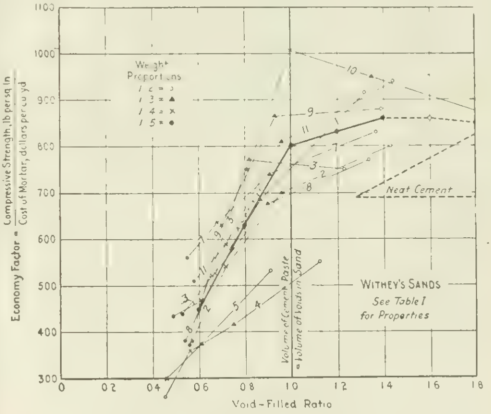

Fig. 3—Variation in Economy Factor in Proportion to Void Filled Ratio.

$$\text{Economy Factor} = \frac{\text{Compressive Strength (lb. per sq. in.)}}{\text{Cost of Mortar (dollars per cu. yd.)}}$$

$$= \frac{\text{Compressive Strength} \times \text{Yield}}{C_r + \dfrac{P_s \times C_s}{P_r} + \dfrac{P_c \times C_c}{P_r}} \quad \ldots\ldots\ldots\ldots(8)$$

P_c, P_s, P_r being the volumetric proportions and C_c, C_s and C the costs in dollars per cubic yard of cement, sand and rock, respectively. The yield is based on the volume of the coarse aggregate (rock) as unity.

There are no test data extant on the economical proportions of concrete. Some tests have been made by the United States Bureau of Standards, using the void theory of proportioning in a limited way. The results of these tests will be analyzed in the following discussion and may throw some light on the subject:

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[3] It should be noted here that this value for the "economy factor" of neat cement mortar, as well as the other factors in Fig. 3, is based upon the assumption that 1 bag of cement gives 1 cu. ft. of cement paste. If, as has been done in this paper, it is assumed that it requires 110 lb. of cement to make 1 cu. ft. of neat cement paste, the cost of a cubic yard of cement mortar would be \$11.85 instead of \$10.14, giving an "economy factor" of 590.

The economy of any mixture depends largely upon the local cost of materials. If the cost of cement is twelve to fifteen times that of the aggregates, the economy of leaner mixtures will be more apparent. In Table VI, the economy factor for several 1:2:4 mixtures is compared with that of several void-theory mixtures, the factors having been computed by the writer from the results shown in Tables VIII and XII of the Bureau of Standards paper.[4] The void-theory mixtures may be expressed by Eqs. 9 and 10, the void-filled ratio (1 to 1.5) being 1.1 in every case both for the mortar and for the rock. The cost of the aggregates was assumed at $1.20 per cubic yard and the cost of cement at $12 per cubic yard. The yield of the various mixtures is necessarily assumed as unity, as it is not possible to closely approximate the yield by calculation.

It would appear from a study of this table that the void-theory mixtures compare quite favorably with 1:2:4 mixtures, considering efficiency. The two combinations of granite show the 1:2:4 mixtures as the most efficient. However, there are too few combinations to be conclusive.

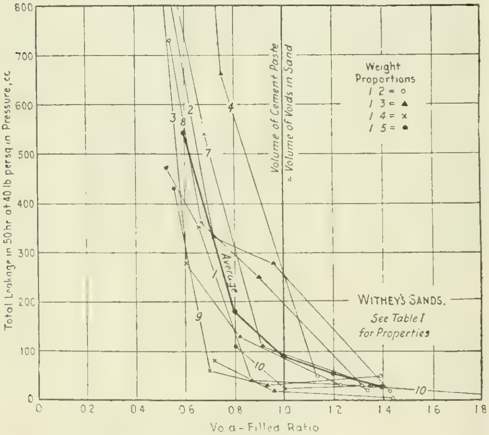

Fig. 4—Variation in Leakage of Mortars in Proportion to Void Filled Ratio.

In Table VII the economy factor is shown for various combinations of aggregates in three mixtures, 1:2:4, 1:3:6 and a void-theory mixture. In 33 comparisons the ratios for the most economical mixtures are as follows:

Theoretical	1:2:4	1:3:6
18	15	
30		3
	30	3

The ratio of cement to total aggregate is 1:8.12 for the theoretical mixture, compared to 1:6 and 1:9 for the 1:2:4 and 1:3:6 mixtures. The fact that the 1:9 arbitrary mixture is much less efficient than an average 1:8.12 theoretical mixture and that the 1:8.12 theoretical mixture is somewhat more efficient than the 1:6 arbitrary mixture would appear to indicate that there is some basis for the void theory.

The 1:2:4 mixture generally appears to be a very efficient one, and the explanation may be the efficiency of the mortar. As the voids in sands are seldom below 33 per cent or above 50 per cent, the ratio of cement paste to voids for the 1:2 mortar varies from 1 to 1.5, which corresponds to the limits previously determined for efficient mortars. Rock seldom shows less than 35 per cent or more than 50 per cent of voids, so that in a 1:2:4 mixture the volume of mortar will vary from 1 to 1.5 times the volume of voids in the rock. A 1:3:6 mixture is seldom an efficient one because a 1:3 mortar is seldom efficient, few sands showing less than 33 per cent voids.

Conclusions Regarding Concretes.

1. An important function of a mortar in concrete is to fill the voids in the coarse aggregate.
2. The efficiency of a concrete mixture depends largely upon the efficiency of the mortar.
3. For economical proportions the volume of cement should be equal or greater than the volume of voids in the sand but not to exceed a multiple of 1.5, and the volume of mortar should be equal or greater than the volume of voids in the coarse aggregate but not to exceed a multiple of 1.5.

TABLE VI.—ECONOMY FACTORS COMPARING 1:2:4 MIXTURES WITH VOID-THEORY MIXTURES.

Kind of Aggregate.		Age at Test, Weeks.					
		4	13	26	52	78	104
		1:2:4 Mixtures—2 Combinations.[1],[4]					
Granite....	Minimum	490	630	700	990	....	....
	Average	510	720	710	1010	....	....
	Maximum	540	820	720	1040	....	....
		Void-Theory Mixtures—2 Combt'ns.[2],[4]					
	Minimum	410	510	590	880	....	....
	Average	440	620	670	900	....	....
	Maximum	470	730	750	920	....	....
		1:2:4 Mixtures—20 Combinations.[1]					
Limestone	Minimum	260	360	450	780	1140	1280
	Average	570	680	750	990	1260	1410
	Maximum	820	820	940	1360	1520	1500
		Void-Theory Mixtures—20 Comb't'ns.[3]					
	Minimum	300	390	410	470	1210	....
	Average	600	760	800	890	1330	1710
	Maximum	890	1020	1050	1440	1590	....
		1:2:4 Mixtures—10 Combinations.[1]					
Gravel.....	Minimum	200	300	390	440	....	....
	Average	550	600	740	810	....	....
	Maximum	870	1040	1090	1190	....	....
		Void-Theory Mixtures—8 Comb't'ns.[2] [3]					
	Minimum	280	420	460	530	....	....
	Average	560	680	740	820	....	....
	Maximum	1080	930	1110	1220	....	....

[1] From Table 8 of Technologic Paper No. 58.
[2] From Table 12 of Technologic Paper No. 58.
[3] The two last combinations of Table 12 have been omitted, since they were not common to both mixtures.
[4] Two combinations in common to both mixtures used.

TABLE VII.—COMPARISON OF THE ECONOMY FACTORS OF CONCRETES PROPORTIONED BY THE VOID METHOD AND ARBITRARILY PROPORTIONED MIXTURES 1:2:4 AND 1:3:6, THE COMBINATION OF AGGREGATES BEING THE SAME IN EACH GROUP.[1]

Kind of Aggregate.	Volumetric Proportions.	Age at Test, Weeks.			
		4	13	26	52
Limestone............	1:2.4:4.47	570	720	900	930
	1:3:6	620	690	750	...
	1:2:4	700	750	960	..
	1:2.4:4.45	470	570	680	860
	1:3:6	410	520	600	800
	1:2:4	450	590	660	880
	1:2.4:5.46	800	1000	1050	900
	1:3:6	790	810	1010	1030
	1:2:4	600	820	...	1040
	1:2.6:6.8	640	760	840	1000
	1:3:6	570	750	820	860
	1:2:4	830	...	830	1240
	1:2.4:5.81	670	900	930	710
	1:3:6	490	730	840	970
	1:2:4	540	820	810	970
Granite..............	1:2.4:4.92	470	720	750	920
	1:3:6	380	440	520	580
	1:2:4	540	820	720	980
Gravel................	1:2.4:7.0	640	820	790	...
	1:3:6	410	540	610	...
	1:2:4	700	...	920	...
	1:2.4:6.2	940	930	1110	1220
	1:3:6	410	590	680	860
	1:2:4	860	1030	1090	1190
	1:2.3:6.4	750	930	990	...
	1:3:6	410	570	650	...
	1:2:4	700	...	970	...
Average..............	Void Theory	661	817	893	934
	1:3:6	509	624	719	850
	1:2:4	658	805	875	1050

[1] See Table 13, Technologic Paper No. 58.

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[4] Technologic Paper No. 58, U. S. Bureau of Standards.

4. The equations for economical mixtures may be stated as follows:

$$\frac{\text{Volume of Sand}}{\text{Unit Volume of Cement}} = \frac{1}{(1 \text{ to } 1.5) \times \text{Proportion of Voids in Sand}} \qquad (9)$$

$$\frac{\text{Volume of Rock}}{\text{Unit Volume of Cement}} = \frac{\dfrac{\text{Volume of Sand} \times \text{Yield of Mortar}}{\text{Unit Volume of Cement}}}{(1 \text{ to } 1.5) \cdot \text{Proportion of Voids in Rock}} \qquad (10)$$

5. The economy factor expresses the relative efficiencies of concrete mixtures and may be determined by Eq. 8.

Street Cleaning Costs at Houston, Texas

During 1916, 1,319,900 sq. yd. of "permanent" paved street surface at Houston, Tex., were cleaned by the Street and Bridge Department. The following data on the cost of this work are taken from the last annual report of Matt Drennan, Street and Bridge Commissioner.

Street Sprinkling.—The motor sprinkling covered 250 blocks twice daily and 57 blocks four times daily. The total yardage sprinkled each day was 1,083,000 sq. yd. In 1916 the motor sprinkler was in operation for 262 days. The total yardage sprinkled was 283,746,000 sq. yd. and the total cost was:

	Per day.	Total, 262 days.
Chauffeur	$3.00	$1,080
Gasoline	1.80	372
Lubricants	.50	131
Repairs and renewals	4.20	1,255
Total	$9.50	$2,838

This gives a cost of approximately 1 ct. per 1,000 sq. yd. of street surface sprinkled.

About 1,632,000 sq. yd. of street surface were sprinkled each day by mule-drawn sprinklers. Six of these outfits were in use at a daily cost of $25, made up of the following items:

6 drivers	$12.00
12 mules	12.00
Renewals	1.00
Total	$25.00

The team outfits sprinkled 350 blocks twice daily and 97 blocks four times daily, and were operated for 300 days, making the total area of street sprinkled in this way 489,600,000 sq. yd. The cost was as follows:

300 days' operation	$7,500
66 days idle mules	780
Total	$8,280

This makes the cost per 1,000 sq. yd. 1.75 ct.

Street Sweeping.—The street sweeping was carried out with mule-drawn sweepers, truck-drawn sweepers and combination sprinkler-sweepers. The unit costs by each of these methods were as follows:

	Per 1,000 sq. yd. Ct
Mule-drawn sweepers	12½
Truck-drawn sweepers	12⅛
Combination sprinkler-sweeper	6⅔

In all 177,000 sq. yd. of street surface were swept daily by three mule-drawn sweepers preceded by one team sprinkler. These outfits operated 294 days in 1916, during which time 52,000,000 sq. yd. of street were swept. The cost of the work was:

	Total per day.	Total, 294 days.
4 men	$8.00	$2,352
8 mules	8.00	2,352
Brooms, renewals and repairs	2.20	740
½ foreman	1.50	490
Total		$5,934
8 mules, idle 72 days		706
Total		$6,440

Two trucks, each trailing one sweeper and preceded by a motor sprinkler, cleaned 300,000 sq. yd. of street surface daily. These outfits operated 270 days at a daily cost of—

2 chauffeurs	$ 7.00
Gasoline	3.60
Lubricants	1.00
Repairs and renewals	4.00
Broom repairs and renewals	4.35
2 men riding brooms	4.00
½ foreman	1.50
	$25.45
Motor sprinkler ahead	9.50
Total	$34.95

The two combination sprinkler sweepers covered 161,000 sq. yd. of street surface each day and were operated for 294 days in 1916. The cost was as follows:

	Total per day.	Total, 294 days.
2 men	$4.00	$1,176
4 mules	4.00	1,176
Broom renewals and repairs	1.70	288
Total	$9.70	$2,852
4 mules, idle 72 days		288
Total		$3,140

White Wings and Pick Up.—In the business district a force consisting of 13 men and a foreman cleaned 222,000 sq. yd. of street surface daily except on Sunday, when they cleaned about one-half this amount. The total cost was as follows:

Men, $185.90 weekly	$10,126
Supplies	500
Total	$10,626

About 47,645,000 sq. yd. were cleaned in the year, making the cost 22½ ct. per 1,000 sq. yd.

The force employed on pick-up work on the business streets consisted of the following:

	Per day.
6 men	$12.00
6 mules	6.00
Renewals and repairs	1.00
Total	$19.00

This gang picked up sweepings last year from 20,878,000 sq. yd. street surface at a cost of 33¼ ct. per 1,000 sq. yd. surface. It removed 6,184 cu. yd. sweepings at a cost of $1.10 per cubic yard.

General pick-up work was handled by an outfit consisting of two trucks, two chauffeurs, 10 men and foreman; also six mule teams, 12 men and foreman.

Daily cost operating two trucks—

Two chauffeurs	$ 7.00
Gasoline	3.60
Lubricants	1.00
Depreciation, renewals and repairs	4.00
Foreman	3.00
Ten men	20.00
Total	$38.60

Picking up daily sweeping from 128,700 sq. yd. street surface. Removing 20 cu. yd. sweepings.

Operating cost working 270 days last year picking up sweepings:

Two chauffeurs	$ 2,160.00
Gasoline	972.00
Lubricants	362.00
Renewals and repairs	1,080.00
Foreman	936.00
Ten men	5,400.00
Total	$10,910.00

Picked up last year (270 days) sweepings from 34,750,000 sq. yd. street surface at a cost of 31¾ ct. per 1,000 sq. yd. Removing 5,700 cu. yd. sweepings at a cost of $1.91 per cubic yard.

Daily cost of six-team pick-up equipment—

12 men	$24.00
12 mules	12.00
Foreman	2.50
Repairs and renewals	2.00
Total daily	$40.50

Picking up sweepings from 185,900 sq. yd. street surface. Removing 45 cu. yd. sweepings.

Team pick-up equipment cost last year, operating 294 days—

12 men	$ 7,056.00
12 mules	3,528.00
12 mules, idle 72 days	864.00
Foreman	810.00
Repairs and renewals	600.00
Total last year	$12,858.00

A Method for Determining Apparent Specific Gravity of Fine Aggregates

A method for determining the apparent specific gravity of non-homogeneous fine aggregates in such a manner that the porosity of the grains would be provided for, was described by Mr. A. S. Rea in a paper presented at the last annual meeting of the American Society for Testing Materials. This method has proved most satisfactory from the standpoint both of accuracy and convenience, and has been adopted in the Testing Laboratory of the Ohio State Highway Department as a standard test. The method follows:

Five hundred grams of the thoroughly dried sample are placed in a 500-cc. graduated cylinder provided with a glass stopper. Approximately 20 cc. of kerosene or a sufficient quantity to saturate the grains and allow for a slight excess is then poured into the cylinder. The stopper is inserted and the cylinder is vigorously shaken until all of the sand grains appear to be coated with kerosene. A measured quantity of water, usually 250 cc., is then introduced into the cylinder. The cylinder is then thoroughly shaken to bring the excess of kerosene to the surface of the water. The two liquids, kerosene and water, being non-miscible and of different specific gravity, a clean line of demarcation will form between them and the reading of the volume of water can be readily obtained. From the dry weight of the aggregate and the volume of the liquid displaced, the "apparent" specific gravity of the aggregate can be calculated.

In this method the grains of sand retain the kerosene in their pores by capillary attraction, so that in displacement the volume is not that of the substance composing the grains, but the volume of the grains themselves. Any excess of kerosene beyond that necessary to fill the pores rises to the surface of the water.

In order to determine whether an appreciable film of kerosene adheres to the surface of the grains, which would thus result in an increased volume of liquid displaced with a consequent lowering of the specific gravity, determinations by this method were made on standard Ottawa sand. This sand is composed of practically pure quartz grains, hence its absorption need not be considered. The results showed this film to be so slight as not to appreciably affect the results.

To determine on the other hand whether the grains will completely retain the kerosene in the cavities or pores during the process of shaking the sand in water, a series of determinations was made on samples of crushed stone and slag of pre-determined specific gravity. The results here showed that except in cases where the aggregate contained unusually large cavities or pores, as in some very porous slags, this method was entirely satisfactory.

In making the specific gravity determination by this method, it is essential for accurate results that the aggregate be clean. If the sand contains an appreciable percentage of silt it should be washed, otherwise the silt will be held in suspension in the kerosene at the top of the water, thus introducing a slight error as well as making the reading more difficult. In order to show the difference in the results obtained by this method as compared to the old displacement method, the results obtained in one series of tests are given in Table I.

From the figures given in the table, it will be noted that the difference in the specific gravity by the two methods ranges from zero with the Ottawa quartz sand which has a negligible absorption to 0.13 in the case of sand G-1321 which is a very coarse-grained sand consisting almost entirely of rounded sandstone fragments. Between these limits the specific gravity of the sands show variations depending upon the extent of the porous grains present in the sand.

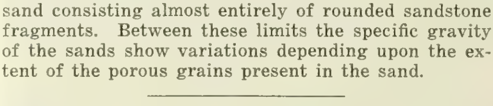
TABLE I.—RESULTS OF SPECIFIC GRAVITY DETERMINATIONS.

Sample.	By usual displacement method.	By method described.	Variation.
Standard Ottawa sand	2.65	2.65	0.00
Limestone screenings	2.63	2.55	0.08
Sandstone	2.47	2.41	0.06
Sand G-1312	2.63	2.52	0.11
Sand G-1319	2.60	2.50	0.10
Sand G-1320	2.59	2.46	0.12
Sand G-1321	2.63	2.50	0.13
Sand G-1325	2.60	2.58	0.02
Sand G-1328	2.57	2.54	0.03
Sand G-1329	2.63	2.62	0.01
Sand G-1331	2.72	2.66	0.06
Sand G-1333	2.63	2.60	0.03
Sand G-1336	2.65	2.63	0.02
Sand G-1341	2.53	2.48	0.05

Concrete Road Construction on Water Soaked Sub Grade

A concrete road, over a mile in length, has been constructed across a very swampy piece of ground by the County Highway Department of Milwaukee County, Wisconsin. Part of the road was built in 1916 and the remainder in 1917. The road was built under very bad drainage conditions. The territory is almost flat and water stands for a long time in the ditches and the surrounding land.

The concrete surfacing was 18 ft. wide and was reinforced with American Steel & Wire Co.'s No. 29 wire mesh. The sections were from 500 to 1,000 ft. in length, and at the places where construction was stopped for the night, the reinforcement through the blind joints consisted of ¼-in. rods 4 ft. long extending through holes bored in a wooden header, as shown in the accompanying sketch.



Method of Carrying Reinforcement Through Construction Joint.

Regarding the present condition of the road, Mr. H. J. Kuelling, formerly County Highway Commissioner of Milwaukee County, writes as follows:

"This road came through the winter in exceedingly good condition and so far as I could see free from longitudinal and transverse cracks. I, however, believe that a great deal of this good condition is due to the fact that the underground conditions are absolutely equal and that the road was raised and lowered uniformly by the frost action. I also believe that there was not an abnormal frost under it, because of the swampy condition of the ground, which, as you know, does not take as much frost as solid ground."

"In other words, I believe that we need not fear building a concrete road across a marsh or swamp. In fact, we should get better results there than on a non-uniform soil. While the drainage conditions are exceedingly bad, the uniformity of the conditions gives good results."

Cost Plus Fixed Sum Per Unit Contracts for Highway Work

The Massachusetts Highway Commission, of which Mr. Arthur W. Dean is Chief Engineer, is now carrying out some of its State highway construction under "cost plus a fixed sum per unit" contracts. This plan has been put into effect with the idea of getting the work done at as reasonable a cost as possible without the element of chance that would necessarily enter into the matter if a contractor were to bid on the work in the usual manner.

On the first contract that was let on this basis this year, the Commission allowed the contractor the cost plus the following sums indicated:

Earth excavation (dry), per cu. yd.	$0.06
Ledge excavation, per cu. yd.	.14
Local broken stone, per ton	.12

and other items in proportion.

Under the new form of contract the contractor was required to furnish the necessary superintendents, foremen, laborers, etc., at compensation agreed upon between him and the Commission. The Commission pays the actual amount paid by the contractor to such persons as shown by his timebooks and checked by a timekeeper employed by the Commission.

The contractor is required to furnish all small tools and implements such as picks, shovels, hammers, wheelbarrows, etc. Machinery is either furnished by the Commission or by the contractor on a rental basis, the rental being agreed upon in the contract.

Under this plan there is no inducement to the contractor to make the cost of the work excessive. On the other hand, there is every inducement to him to get the work done as quickly as possible, and consequently, at low cost, in order to make his profit as quickly as possible. If there is a $5,000 profit to the contractor in the contract, he would rather make that profit in two months than to have the work extend over eight months.

Iron Ore Tailings in Top Finish of Concrete Sidewalks

Iron ore tailings have been used at Albany, N. Y., since 1912 in the top finish of concrete sidewalks. The specifications require the wearing surface to be mixed in the proportion of 1 bag of cement to 2 cu. ft. of clean iron tailings, to which is added and mixed 1 lb. of pure dry lampblack to darken the walks and lessen the glare on sunny days.

The use of the iron ore tailings gives a harder surface and while it does not entirely eliminate dusting, has reduced it so that there is no complaint. It has been noticed that some of the walks in the business section subjected to heavy and constant pedestrian traffic have taken a noticeable polish, so much so that they become somewhat slippery in unfavorable weather. The obvious remedy for this is to make the surface mixture on sidewalks subjected to heavy and constant traffic less rich.

Iron ore tailings cost about $1.60 per yard on cars, while sand costs about 27 ct. per yard at the bank. The wearing surface being but 1 in. in thickness, the large difference in cost between the tailings and sand does not make a very large difference in the cost of the concrete walks per square foot. The total thickness of concrete walks constructed in Albany is 6 in., 5 in. being of 1:2½:4 concrete; the top wearing surface has a thickness of 1 in. and is composed of a mixture as above given.

A 6-in. concrete walk is built in place of the ordinary 4-in. walk because it is felt that the additional bulk or thickness of the former gives a greater stability and is less liable to heave, to get out of line and to crack. It is easy to break, for instance, a 4-in. concrete walk by throwing ice or heavy boxes or anything of this description on the walks.

New Method of Finishing Concrete Pavement

In placing a two-course concrete pavement on 11th St., Wichita Falls, Tex., a novel method of finishing was employed which gave most excellent results. The method is described as follows in the August Concrete Highway Magazine:

Two 1x6-in. boards, each equal in length to one-half the width of the pavement, were spliced so as to make a jointed plank, the length of which was equal to the width of the street. At each end of this was nailed a short piece of 2-in. stock so notched that the outer end rested on the curb and the bottom of the float was at the gutter grade. A hole was bored near the lower end of this at an agle of about 30°. Wooden handles were inserted, as shown in the picture. A man at each end then pushed and pulled the float over the pavement, finishing in one operation the whole width of the street, the float being drawn across the surface as many times as was necessary to obtain the required evenness.

Finishing Concrete Pavement With Jointed Plank Float.

This process eliminated much of the excess water and gave an even surface, but one not as gritty as that produced by the belt finish.

The city of San Diego, Cal., has been operating vacuum street cleaning machines for the last four years. The apparatus is drawn by three horses and the vacuum arrangement is run by a small gas engine. The machine is handled by one gas engineer and one teamster. The first sweeper was purchased in the fall of 1912 and the second in March, 1913. The total cost was $2,200.

The State Highway Department of Ohio opened bids recently on road work estimated to cost nearly $2,000,000. A new letting calling for an expenditure of nearly $1,000,000 is now advertised.

Ohio Method of Patching Bituminous Pavements

The requirements of the Ohio State Highway Department for patching bituminous pavements as embodied in the new standard road specifications of Clinton Cowen, State Highway Commissioner, are as follows:

The depression or area to be patched is thoroughly cleaned of all loose or matted dirt or foreign material and swept clean of all dust. When clean and dry, the depression is painted with the same kind of bituminous material as is used in preparing the bituminous concrete. When the depression is deeper than 3 in., it is first filled to within 2 in. of the road surface with No. 2 stone (2½ in. to 1½ in.), which must be thoroughly tamped in place. The depression is then filled with bituminous concrete in sufficient quantity to fill the depression to the level of the surface of the surrounding pavement after the bituminous concrete is thoroughly compacted. The patch is covered with sufficient grit (material passing through a ½-in. opening and retained on a No. 8 sieve) to prevent the bituminous material from sticking to the wheels of the roller and is then thoroughly compacted by rolling. The surface is finally covered with No. 6 grit (material passing ½-in. opening and retained on No. 8 sieve) or clean, coarse sand, to protect the patch while setting up.

The bituminous concrete is prepared by one of the two following methods, using the same kind of aggregate as was used in the original construction of the road; also same type of bituminous material as used in original construction, that is, either tar or asphalt.

When an asphalt bound road is to be patched, the bituminous concrete consists of a mixture of cut back asphalt and No. 4 size stone (material passing through a ¾-in. and retained on a ¼-in. opening) or slag in proportion of ⅝ to ⅞ gal. of bituminous material to 1 cu. ft. of aggregate. The aggregates are thoroughly and uniformly mixed on a tight platform by hand methods or in a concrete mixer until each particle of stone is completely coated with the bituminous material. After mixing, the bituminous concrete it is stored where it will be free from dust or dirt for 24 hours, or until the bituminous material stiffens sufficiently to bind when the patch is made. When required by the Commissioner, a small amount of clean, coarse sand may be added to the aggregate.

A cold patch asphalt emulsion is sometimes used in place of the cut back asphalt. When the emulsion is used the proportions are ⅔ to ⅞ gal. to 1 cu. ft. of the stone chips. This mixture is used immediately after being mixed.

When a tar bound road is to be patched, the bituminous concrete consists of a mixture of tar and No. 4 size stone or slag in the proportion of ⅝ to ⅞ gal. of bituminous material to 1 cu. ft. of stone. The aggregate is thoroughly and uniformly mixed on a tight platform by hand methods or in a concrete mixer until each particle of stone is completely coated with the bituminous material. After mixing the bituminous concrete is stored, where it will be free from dust or dirt for several days until the bituminous mixture stiffens sufficiently to bind when the patch is made.

In either of the above methods the stone must be dry when mixed with the bituminous material and neither stone or bituminous material can have a temperature of less than 45° F. when mixed together.

Requirements of Ohio State Highway Department for Painting Wooden Structures

The new standard road specifications of the State Highway Department of Ohio call for the application of three coats of paint to wooden structures, unless otherwise ordered. For a ready mixed paint the standard "O" white paint is specified. This consists of

4 gal. raw linseed oil.
1 qt. drier.
75 lb. white lead in oil.
25 lb. zinc oxide in oil.

Unless otherwise ordered the final coat on all woods where ready mixed paint is used consists of the above. The first and intermediate coats in this case are:

Yellow pine, cypress and similar woods.		Poplar, oak, white pine and similar woods.		
Coats		Coats		
1st	2nd	1st	2nd	
7	7	7	7	gal. "O" white paint
0	½	2	½	gal. raw linseed oil
1½	0	0	0	gal. benzole
1	½	½	½	gal. turpentine.

Where the paint is mixed on the job the different coats for the various woods consist of ingredients proportioned as follows:

Yellow pine, cypress and similar woods.			Poplar, oak, white pine and similar woods.			
Coats			Coats			
1st	2nd	Final	1st	2nd	Final	
3½	4	4	5	4	4	gal. raw linseed oil
1½	0	0	0	0	0	gal. benzole
1	1	1	1	1	1	qt. drier
1	½	0*	1	½	0	gal. turpentine
100	100	75	100	100	75	lbs. white lead in oil
0	0	25	0	0	25	lbs. zinc oxide in oil

*Or little.

Cost of Street Cleaning at Chicago, Ill.

Street cleaning at Chicago in 1916 by the block and gang system cost $1,392,245, according to the last annual report of the Department of Public Works. A total of 4,677,637,117 sq. yd. of streets cleaned by this system, required the collection and removal of 528,109 cu. yd. of street dirt. In addition, 76,396 cu. yd. of dirt were curbed. The unit costs of the street cleaning were as follows:

	Per 1000 sq. yd., ct.
Block and gang systems	29.8
Horse drawn flushers	15.2
Squeegee flushers	12.9
Auto flushers	7.4
Sidewalk flushing	1.3

The horse-drawn flushers were employed in 35 wards and cleaned 264,405,000 sq. yd. of streets. In doing this 161,387,500 gal., or 294,967 tanks, of water were used. Sidewalk flushing was carried out in the business district of the 1st Ward. In all, 7,467,000 sq. yd. of walk were cleaned, for which 4,047,000 gal., or 6,745 tanks, of water were used. The squeegee flushers also worked in the 1st Ward, and cleaned 15,328,771 sq. yd. of streets. For this work 4,890,000 gal., or 9,780 tanks, of water were used.

The auto flushers operated on 34,056,039 lin. ft. of streets, the total yardage covered being 181,476,790 sq. yd. During the season the flushers used 9,763 gal. of gasoline, 399 gal. of oil and 350 lb. of grease. The cost of operation was as follows:

Drivers and helpers	$ 6,900
Gasoline, oil, etc.	1,884
Fittings and repairs	4,787
Total	$13,571

End Dumping Trailer Body With Hand Operated Hoist

A trailer body with hand operated hoist for end dumping of particular interest to road contractors has been placed in production by the Archer Iron Works, Chicago. The body is made of steel and has a capacity of 4 cu. yd. The hoist is so managed that one man can easily raise the body with its contents to an angle of 45° in two minutes. A small friction brake controls the lowering operation. The illustration shows one of these bodies mounted on a 5-ton Troy trailer.

Trailer Body and Hoist.

Converting Mountain Trail Into Wagon Road

Road construction in some of the counties of Arkansas is often carried out under difficult conditions. The accompanying illustration shows how Logan County handled one of its problems. The work was located between Boonville and Walnut Grove, and involved the conversion of a mountain trail into a wagon road of sufficient width to admit the passing of two automobiles at any point. The improvement was carried out with a heavy grader hauled by a traction engine. Successive cuts were made in the hillside and the dirt cast down the slope to form the embankment. This side hill work was facilitated by the offset hitch to the engine and by the extended axle of the grader. The first mile of road, which was made under unusually severe conditions and on the mountain side, was completed in 15 hours' actual working time. A Mammoth grader made by the Austin-Western Road Machinery Co. was used on this work.

Side Hill Road Construction With Grader and Traction Engine.

Personals

A. N. Eason and A. N. Garland have opened offices in the Green Bldg., Seattle, Wash., and will engage in contracting.

A. B. Fletcher, State Highway Engineer of California, has been appointed president of the California State Reclamation Board, succeeding V. S. McClatchy.

Albert McWayne and Robert A. Perkins have opened offices in the Paulton Bldg., Sioux Falls, S. Dak., where they will engage in an architectural and engineering business.

W. K. Palmer, who for 16 years past has been continuously engaged in consulting engineering practice and the head of the firm of The W. K. Palmer Co., engineers, Kansas City, Mo., has accepted a commission as major in the Engineer Corps of the U. S. Army. In consequence his practice and the business of The W. K. Palmer Co. will be discontinued for the period of the war after Sept. 1, 1917. Major Palmer organized engineer troops at the beginning of the war and has been actively engaged in military matters for some time past, and is now in Kansas City on a 5 days' leave from Fort Sill, Okla., for the purpose of closing up business affairs connected with his practice and the business of The W. K. Palmer Co.

Industrial Notes

A large addition is being made to the plant of the Pulsometer Steam Pump Co., Irvington, N. J.

The Buff & Buff Mfg. Co. of Boston has purchased the plant formerly owned by R. Seelig Co.

The Rochester Excavating Machinery Co., Inc., is now occupying its new factory at Caledonia, N. Y.

The Houston Buick Sales Co. will henceforth handle Garford motor truck sales in the Houston territory.

J. W. Dopp & Co., 18 Columbia St., W., Detroit, are now representing the T. L. Smith Co. of Milwaukee in the Detroit territory.

The Emerson-Brantingham Implement Co., Rockford, Ill., announces the appointment of C. E. Leslie as advertising manager.

The C. H. Englee Co., 120 Milk St., Boston, is the name of a new contracting firm organized by Charles H. Englee, formerly with the Aberthaw Construction Co.

The entire plant of the Kent Machine Co., manufacturers of concrete mixers, has been taken over by the Falls Rivet Co., Kent, Ohio. The business has been reorganized and will be continued under the name of the Kent Machine Co.

J. H. Jowett has been elected vice-president of the Ingersoll-Rand Co. and J. D. Albin succeeds Mr. Jowett as general sales manager. Both Mr. Jowett and Mr. Albin will continue to make the company's New York office their headquarters.

T. M. Avery, one of the New York City representatives of the Blaw-Knox Co., has been placed in charge temporarily of the San Francisco office. Edward M. Ornitz, the San Francisco representative, has joined the Engineering Corps as First Lieutenant.

Offices have been opened in the Conway Building, Chicago, by the Hollow Building Tile Association, composed of manufacturers representing 90 per cent of the total production of this burned clay product. Mr. E. R. Sturtevant, until recently a successful manufacturer of hollow tile, has been elected secretary and treasurer.

The Walter A. Zelnicker Supply Co., St. Louis, has secured the services of J. C. Bryan, formerly with Manning, Maxwell & Moore, Inc., as southwestern representative of The Ashcroft Manufacturing Co., The Consolidated Safety Valve Co., The Hayden & Derby Mfg. Co., and The Hancock Inspirator Co. Mr. Bryan will be associated with the equipment department of the Zelnicker Co.

Mr. A. W. Ransome, who for nearly 20 years has been closely identified with the development and manufacture of concrete machinery, has joined with the Blaw-Knox Co., Pittsburgh, Pa. During the past two years, Mr. Ransome has been developing and putting into practice sundry improved patents on concrete machinery, all of which have been purchased by Blaw-Knox Co. and will be marketed and further developed under his direction as manager and chief engineer of the mixer department.

Owing to the expansion in its business the Ransome Concrete Machinery Co. has incorporated anew with larger capital. The new Ransome Concrete Machinery Co. of New Jersey has been incorporated with a capital stock of $1,000,000 and $500,000 cumulative preferred stock and $500,000 common stock. The new incorporation takes over the business and plants of the old Ransome Concrete Machinery Co. of New York. It will enlarge and further expand its business until it will cover the entire line of building contractors' equipment, contractors' machinery and road builders' machinery and equipment. The directorate of the newly incorporated company is as follows: Frank L. Brown, director and president, New York; John J. Givens, director and treasurer, Dunellen; H. K. Brooks, director (vice-president American Express Co.), New York; C. H. Haney, director (sales manager, International Corp.), Chicago; Robt. R. Moody, director, New York; John G. Wood, director (general manager of works, International Harvester Co.), Chicago; G. F. Steele, director (manager News Print Association), New York.

Bids Asked

Roads = Streets

Ala., Carrollton—Until Sept. 25 by B. G. Robinson for constructing 50 miles of road, including grading, graveling and constructing bridges, involving 165,000 cu. yds. grading, 40,750 cu. yds gravel. Gus E. Hauser, Engineer, Columbus, Miss.

Ala., Livingston—Until Sept. 24 by W. S. Keller, State Highway Engineer, Montgomery, Ala., for grading and draining State trunk road No. 7 between here and Gainesville, Ala.

Ala., Russellville—Until 3 p. m., Sept. 29, by A. J. Earle, City Engineer, for constructing grade work, gravel paving, concrete culverts and concrete curb and gutter.

Cal., Mare Island—Until Sept. 17, by Bureau of Yards and Docks, Navy Department, Washington, D. C., for grading at navy yard here.

Cal., Oxnard—Until 7:30 p. m., Sept. 11, by Frank B. Pettis, City Clerk, for grading and paving with 4-in. concrete pavement, 1½-in. asphaltic concrete wearing surface, cement curbs and gutters on Savier's Road.

Cal., Pasadena—Until 10 a. m., Sept. 11, by Heman Dyer City Clerk, for improving portion of Hudson Av.

Cal., San Bernardino—Until 7:30 p. m., Sept. 17, by City Clerk, for improving South Arrow Head Av. with 4-in. concrete base and asphaltic oil wearing surface.

Cal., Santa Ana—Until 2 p. m., Sept. 18, by W. B. Williams, Clerk, Board of Supervisors, Orange County, for grading approximately 1900 ft. of Brea-Olinda Road and removing approximately 4600 cu. yds, of earth.

Cal., South Pasadena—Until 5 p. m., Sept. 17, by V. B. Garwood, City Clerk, for paving Fremont Ave. with 5-in. concrete paving, involving approximately 216,000 sq. ft.

Fla., Kissimmee—Until Sept. 17, by J. L. Overstreet, Clerk, Osceola County, for constructing brick road in districts Nos. 1 and 2.

Ida., Pocatello—Until 5 p. m., Sept. 16, by A. R. Dawson, City Clerk, for resurfacing pavements involving 5,400 sq. yds. of concrete paving.

Ida., Wallace—Until 8 p. m., Sept. 10, by David H. Delong, City Clerk, for paving portions of streets including concrete curbs and gutters. Total estimated cost $12,990.

Ill., Morrison—Until 2 p. m., Sept. 18, by V. N. Taggett, County Superintendent of Highways, for 16,046 sq. yds. of gravel road for highway commissioners of Albany. Advertisement in this issue.

Ill., Paris—Until 11 a. m., Sept. 17, by Commissioners of Highways, Hunter Twp., Edgar County, Superintendent Office, for constructing 3,000 lin. ft. gravel road on Heelan Road and 3,000 lin. ft. on Baldwinsville-State Line Road.

Ind., Columbus—Until 10 a. m., Sept. 21, by W. H. Scott, County Auditor, Bartholomew County, for constructing 11,074 ft. and 11,294 ft. gravel road in Flatrock and German Twps., respectively.

Ia., Cherokee—Until 2 p. m., Sept. 10, by W. O. Dailey, County Auditor, Cherokee County, for graveling 5½ miles of Marcus Southern Section of county road system.

Ia., Ottumwa—Until 10 a. m., Sept. 14, by City Clerk, for furnishing material and laying approximately 10,925 sq. yds. paving. Horace A. Brown, City Engineer. (Advertisement in this issue.)

Ia., Sidney—Until 2 p. m., Sept. 12, by Rees B. Ellis, County Auditor, Fremont County, for grading with approximately 50,000 cu. yd. and incidental road work in Sydney Twp. and Riverton Twp. Work can be done with small dredge.

La., Cameron—Until Sept. 22, by Board of Supervisors, Road District No. 1, Cameron County, for grading and bridging road in Hackberry, a distance of 5.5 miles. T. A. Mandell, Lake Charles, La., Engineer.

Mass., Quincy—Until 10 a. m., Sept. 10, by Commissioner of Public Works, City Hall, for laying about 2,500 sq. yd. granite block pavement on concrte base, furnishing and setting about 1,300 lin. ft. of edgestone. Moses L. Brown, Commissioner of Public Works.

Minn., Buffalo—Until 2 p. m., Sept. 11, by John A. Berg, County Auditor, Wright County, for grading and graveling state roads Nos. 8 and 9.

Minn., Columbia Heights—Until 8 p. m., Sept. 11, by J. N. Thull, Village Clerk, for constructing sidewalk. J. E. Hill, Village Engineer, 314 Nicollet Av., Minneapolis, Minn.

Minn., Mantorville—Until 2 p. m., Sept. 12, by Geo. L. Taylor, County Auditor, Dodge County, for hauling and placing 2,400 cu. yds. of gravel on state road No. 1 in Section 35 and 36, Town 107, Range 17.

Minn., St. Peter—Until 8 p. m., Sept. 10, by M. E. Stone, City Clerk, for constructing curb and gutters on and along certain parts of Nassau St. and Park Row.

Minn., Wadena—Until 8 p. m., Sept. 12, by A. C. Murray, Village Clerk, for graveling 5th St. L. P. Zimmerman, City Engineer.

Mo., Kansas City—Until 2 p. m., Sept. 12, by T. C. Harrington, Secretary, Board of Park Commissioners, City Hall, for furnishing material and constructing bituminous macadam pavement on roadway in Paseo.

Mont., Ronan—Until Sept. 10, by E. T. Crawford, City Clerk, for macadamizing and curbing streets and conduits at a cost of $12,000. Gerharz-Jaquah Engineering Co., Great Falls, Mont., Engineers.

Neb., O'Neill—Until 2 p. m., Sept. 11, by August Wabs, Clerk, Coleman Twp. Board, for grading 1¾ miles new grade, two miles re-grading, three miles repairing roads in Coleman Twp., Twp. 32, range 12. Grades to be 20-ft. wide, 16-in. fill at center and to slope one inch to a foot on each side.

N. Y., Albany—Until 1 p. m., Sept. 29, by State Commission of Highways, 55 Lancaster St., Albany, for 3-in. brick resurfacing on 5-in. concrete base road in Ridge-Rochester, Sea Breeze, in Monroe County.

New York, N. Y.—The following contracts were awarded by Marcus M. Marks, President, Borough of Manhattan, 2032 Municipal Bldg., Manhattan, for repaving with granite block and sheet asphalt several streets in city. P. Cramer, 114 E. 52nd St., at $1,552, and the Cleveland Trinidad Paving Co., Flushing, N. Y., at $32,238.

Ohio, Cleveland Heights—Until noon, Sept. 17, by H. H. Canfield, Clerk of Village, for furnishing material and constructing brick, sergent block and vitrified pipe, storm and sanitary sewers in the Taylor-Caledonia sewer district No. 5. F A. Pease Engineering Co., 804 Marshall Bldg., Cleveland, O.

Ohio, Columbus—Until 2 p. m., Sept. 7, by Clinton Cowen, State Highway Commissioner, for constructing section 2 of the Wooster-Millersburg road in Wooster Twp., including grading, constructing bridges and culverts and paving with monolithic brick, 10 ft. wide, 26-ft. roadway, about 1.17 miles. Estimated cost, $22,076; also for Section A of same road, .88 mile, at $15,081.

Ohio, Columbus—Until 2 p. m., Sept. 7, by Clinton Cowen, State Highway Commissioner, for the following improvements: Adams County, Section "B," West Union-Hillsboro Road, Wayne Twp., grading, paving with waterbound macadam and constructing bridges and culverts, 1.06 miles; estimated cost, $9,211. Section "C"-2 of West Union-Sinking Spring Road in Meigs Twp., grading, paving with waterbound macadam and constructing culverts, 1.33 miles, at $8,500. Ashtabula County, Section "C," Youngstown-Conneaut Road, constructing drainage structures, grading roadway and paving about 5 miles, monolithic brick, $114,656; concrete, $100,033. Butler County, Section "I," Hamilton-Middletown Road, Lemon Twp., bridges and culverts, grading roadway, grading monolithic brick, $75,964; reinforced concrete, $67,935. Section "J," same road, monolithic brick, $81,875; reinforced concrete, $71,625; 3.54 miles. Crawford County, Section "L," Galion-Bucyrus Road, in Jefferson Twp., grading, constructing culverts and bridges and paving with brick on concrete base, 1.79 miles at $55,248. Green County, Section "I," Wilmington-Xenia Road, in Caesar Creek Twp., constructing bridges and culverts, grading roadway, paving with waterbound macadam, 5.05 miles, at $56,653. Guernsey County, the McConnellsville-Cambridge Road, Section "A," Spencer Twp., grading, constructing drainage structures and paving with bituminous macadam, 1.44 miles, at $22,371. Hancock County, Section "A-1," Ottawa-Findlay Road, Liberty Twp., grading roadway, constructing bridges and culverts and paving with reinforced concrete, 1.28 miles, $27.305; brick, $37,417; asphalt concrete, $31,719. Highland County, Section "K," Hillsboro-Piketon Road, Liberty Twp., grading, paving with bituminous macadam and constructing culverts, 2.40 miles, at $22,730. Highland County, Section "H," Allensburg-Lynchburg Road, grading, paving with waterbound macadam and constructing culverts, 1.43 miles, at $11,744. Jackson County, Section "F," Chillicothe-Jackson Road, Liberty Twp., constructing bridges and culverts, grading roadway and paving with waterbound and bituminous macadam, 1.86 miles, at $18,165. Knox County, Section "K," Columbus-Wooster Road, Monroe Twp., constructing bridges and culverts, grading roadway and paving with reinforced concrete, 1.61 miles, at $46,389. Lake County, Section "B," Euclid-Chardon Road, Willoughby Twp., constructing drainage structures, grading roadway and paving with reinforced concrete, 2.25 miles, at $36,498. Lawrence County, Section "E," Ironton-Miller Road, Upper Twp., constructing bridges and culverts, grading roadway and paving with bituminous macadam, one mile, at $15,214. Lawrence County, Section "K," Ohio River Road, Union Twp., .97 mile, grading roadway, constructing bridges and culverts and paving with concrete, at $20,027; or bituminous macadam at $17,780. Madison County, Section "A-1," Columbus-Cincinnati Road, 3.28 miles, in Deer Creek and Union Twps., grading roadway, constructing bridges and culverts and paving with waterbound macadam, at $51,657; bituminous macadam, $51,563; monolithic brick, $51,550. Medina County, Section "P-1," Cleveland-Wooster Road, in Brunswick Twp., constructing drainage structures, grading roadway and paving with monolithic brick pavement, .73 mile, at $21,328. Mercer County, Section "E-1," Fort Recovery-Minister Road, 1.22 miles, grading roadway, constructing bridges and culverts and paving with concrete, at $31,210. Monroe County, Section "N," Ohio River Road, in Ohio Twp., grading, constructing drainage structure, .95 mile, at $15,167. Muskingum County, Section "L," Zanesville-Cincinnati Road, Newton Twp., .82 mile, grading, constructing drainage structure and paving with bituminous-bound macadam, at $13,183. Pickaway County, Section "L-1," Lancaster-Circleville Northern Road, Walnut Twp., grading roadway, constructing bridges and culverts and paving with waterbound macadam, 1.37 miles, at $24,109. Portage County, Section "V," Akron-Youngstown Road, Edinburg Twp., grading roadway, constructing bridges and culverts and paving with concrete, 2.69 miles, at $46,933; bituminous macadam at $42,618; monolithic brick, $59,656. Preble County, Section "C-2," Hamilton-Eaton Road, Gasper Twp., .52 mile, grading, paving with bituminous macadam and constructing culverts, $8.148. Ottawa County, Section "F-1," Bowling Green-Pt. Clinton Road, Salem Twp., constructing drainage structures, grading roadway and paving with brick, .39 mile, at $12,111. Ross County, Section "N," Chillicothe-Lancaster Road, Green Twp., grading roadway, constructing bridges and culverts and paving with semi-monolithic brick, .66 mile, at $15,811; also grading roadway, constructing bridges and culverts and paving with semi-monolithic brick at $28,849. Stark County, Section "G," Ravenna-Louisville Road, Marlboro Twp., grading roadway, constructing bridges and culverts and paving 2.52 miles with bituminous macadam, limestone top course, at $54,571. Summit County, Section "N-1," Cleveland-Massillon Road, in Norton and Franklin Twps., grading roadway, constructing bridges and culverts and paving with brick, 1.80 miles, at $54,980. Section "R," Akron-Canton Road, Springfield Twp., grading roadway, constructing bridges and culverts, paving with brick, 2.08 miles, at $64,501. Union County, Section "B," Marysville-Kenton Road, Paris Twp., grading roadway, constructing

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HALBERT P. GILLETTE, *President and Editor.*
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How to Get Rid of Algae in a Reservoir

For many years following the discovery that copper sulphate kills fresh water algae, Lake Padden, the 140-acre reservoir of the Fairhaven City Water & Power Co., at Bellingham, Wash., was given at least one annual treatment with the sulphate. It was soon found that if the sulphate was used liberally after the spring rains and at the upper end of the lake where a small creek entered it, the spores of the algae were killed so soon after they had been washed into the lake that they never developed to an objectionable extent.

A few seasons ago, however, it occurred to the president of this company, T. W. Gillette, that if the intake of the supply main were raised to a point near the surface of the lake, the spores of the algae would be carried away almost as fast as they were washed into the lake. Accordingly the intake was raised, and since that time it has not been necessary to use copper sulphate to keep the water free from algae.

Simple as this expedient is, we do not recall seeing mention of it in any discussion of this subject. Apparently the spores of algae float and do not permeate the entire body of water, at least until they have germinated. If, then, the surface water is continuously drawn off at a sufficiently rapid rate, the spores will be removed before the water has become contaminated by their growth.

A Cheap Dam Made of Baskets Laid in Steps

The Japanese often protect the face of levees with baskets made of bamboo filled with rock. This design suggested to a San Francisco engineer, J. M. Howells, the construction of a dam whose lower face consists of wire baskets filled with cobbles, laid like a flight of steps, the upper baskets successively overlapping the lower ones. A dam 43 ft. high was thus built to impound the debris from placer mining operations on Scotchman's Creek, California.

The lower face of the dam looks like broad steps, the tread of each step being 4 ft. The units of which the steps consist are baskets made of "chicken wire" filled with coarse gravel, and built in place. Each unit is 1 ft. high, 2 ft. wide and 8 ft. long, placed lengthwise with the creek, and lapping 4 ft. upon the unit below it. A backfill of fine material is placed behind the baskets and seals the dam against excessive leakage, but no attempt is made to make the dam perfectly water tight. With labor at $3 a day the dam was built at a cost of about 50 ct. per cubic yard in place including the cost of the wire netting.

The down-stream face of such a dam will serve as a spillway, but it may be expedient to provide a special spillway.

It would seem that this type of dam might be adapted for other uses than the storage of placer debris. For example, it could be used in controlling rapid streams whose flood waters erode valuable lands or undermine bridges and retaining walls. By building a series of low dams of this character, the hydraulic grade would be so flattened that the velocity, and consequently the erosive action, of the stream would be greatly reduced.

Waterworks Tools and Supplies Carried in a Trailer

The Elmira Water, Light & Railroad Co. has doubled the service rendered with a light motorcar, by providing it with a two-wheel trailer that can carry nearly half a ton of equipment and supplies. The car carries the workmen and hauls the trailer to the job where the trailer is detached and can be pushed by hand from place to place. This leaves the car free to perform other similar service, or for hauling materials.

The trailer itself consists of the front wheels and axle of an old motorcar on which a body, 4x7 ft., is mounted, and provided with a canvas top and sides. Two hinged legs are provided at the rear, to support the trailer when not attached to the motorcar, and a third leg supports the tongue.

In traveling across the continent one sees an increasing number of trailers used for all purposes. Tool-box trailers are among the latest adaptations, and they are especially useful to the construction and maintenance forces of a waterworks.

A Four-fold Increase in Vegetables as a Result of Irrigation

In our last Waterworks and Hydraulic Monthly issue (Aug. 8) we published an exceptionally valuable article on the methods and results of overhead irrigation at the Seabrook Farms, N. J. In that article Mr. Charles F. Seabrook said that his experience with his 600-acre farm justified him in asserting that the yield of vegetables from non-irrigated land in New Jersey is only one-fifth the yield from irrigated land, considering both quantity and quality of product.

The average annual rainfall at Bridgeton, N. J., where the Seabrook Farms are located, is 25 in. Mr. Seabrook applies 12 to 20 in. of irrigation water during the growing season, and uses fertilizers liberally, with results that are fairly astonishing. He grows 1,200 bu. of onions to the acre, 640 bu. of potatoes, and 32 tons of beets (including tops). Moreover, irrigation speeds up the maturing of crops to such an extent as to permit a more rapid succession of crops.

For the engineering features, such as sizes and layout of overhead piping, the reader is referred to the article above mentioned. Our present comment is intended to arouse the interest of civil engineers with a view to leading more of them to take the initiative in designing, installing and operating irrigation plants in the "humid states." We believe that many engineers will find it highly profitable to themselves to promote irrigation projects in the middle, eastern and southern states. In these states irrigation is as yet almost unknown, yet the remarkable success of such men as Mr. Seabrook has demonstrated conclusively that the irrigation of vegetables so greatly increases the output as to make it highly profitable. Farmers are slow to appreciate what can be accomplished by irrigation, and even slower in their attempts to finance the necessary plants. This slowness spells opportunity for engineers who are not equally slow.

The County Surveyor Who Became the "Father of Geology"

Scarcely more than a century ago, for it was in 1814, the first geological map of England was published. It was the work of William Smith, "Strata Smith" as he had come to be called, a man who had educated himself to be a surveyor and then evolved one of the most important of scientific generalizations as a result of his keen observation of the rocks and fossils that he encountered in his daily work.

Samuel Smiles briefly outlines the interesting career of William Smith in his "Self Help," but as this old book is now read only by a few, and as Smith's achievements should particularly interest engineers, we purpose indicating briefly what he accomplished and how.

William Smith was born in Oxfordshire in 1769, the son of a farmer who died early leaving the boy sparingly educated. He began to study surveying, aided only by books, and later became the assistant of a county surveyor who sent him on many trips in his own and neighboring counties. Part of this work involved the mapping of some coal mines, and it is perhaps this that directed his attention most strongly to the formation of the earth's crust. At any rate, he conceived the idea that the strata overlying the coal beds were not horizontal but dipped toward the east, possibly to rise and reappear again. While engaged in levelling for a proposed canal, he confirmed his hypothesis, at least as to the inclination of the strata. Shortly afterwards his canal work took him over a considerable part of England, and on this trip he repeatedly noted not only the frequent reappearance of a peculiar stratum of "red ground" but that it always held the same position relatively to the strata of lias and freestone.

Whether it was on this trip or later that he also noted that each stratum had its characteristic fossils is not stated by Smiles, but his keen eyes and retentive memory soon led him to associate each layer of rock with certain fossils. He remarked to a companion as they neared the foot of the Dunstable chalk hills: "If there be any broken ground about the foot of these hills, we may find sharks' teeth." A few moments later they picked up six teeth from the bank of a newly dug ditch! Smith thus tested his great generalization that stratified rocks are the graveyards of prehistoric creatures and that each stratum marks a period of time.

The geologists of his day, blinded by their own hypotheses and perhaps incensed that a mere surveyor should presume to teach them the history of the earth, were not easily persuaded to adopt the revolutionary theory that ancient seabeds had hardened into rocks. To them the fossil shells and bones and leaves were "sports of nature," fantastic mimicry of life—perhaps sown by the devil to puzzle and deceive mankind.

But "Strata Smith" went about his prose and his poetry, his bread winning and his travels, in search of new information about the rocks and the creatures entombed within them. Finally he built up such an array of evidence in favor of his theory that in 1831 the Geological Society of London awarded him the Wollaston medal, "in consideration of his being a great original discoverer in English geology, and especially for his being the first in this country to discover and to teach the identification of strata, and to determine their succession by means of their embedded fossils."

William Smith's great achievement may never be equaled by another surveyor, as a mere byproduct of professional work, but it should serve to stimulate many an engineer in his determination to observe carefully, record systematically, and think deeply about the facts that come to his attention, or, more properly, about the facts that he industriously accumulates by an increasing effort to gather more information on a given subject than is had by his associates. The first essential to scientific success is the accumulation of usable facts, whether they be used as a basis for a grand generalization or merely to solve a special technical problem.

The Economy of Machines Increases as Wages Rise

The wages of common laborers now exceed $3 a day in many localities and the end of the rise is not in sight. We doubt whether the cessation of the world war will cause any drop in wage rates. If wages remain high, the use of labor saving devices will be more economic than ever. Even where a machine can be kept busy only a small part of the year it will often pay a handsome return on the money invested in it. In estimating the return on an investment in a machine, the mistake is often made of allowing as high an annual depreciation and repair rate for a machine that is actually in use only a short time annually as is allowed for a machine that is in service almost continuously. Since the interest charge on a machine is a comparatively small item, it should be evident that if the depreciation and repair charge is also small it may actually pay to own a machine even where it is kept busy less than one month in a year. This is particularly evident in the case of a machine that is not high priced yet does the work of many men, such, for example, as a power tamper for compacting backfill.

For construction equipment of this class a depreciation and repair rate of 2 per cent per month of actual service is normally an adequate allowance. If, then, the annual interest is 6 per cent and the machine averages only one month of service annually, the total annual interest, depreciation and repair rate is but 8 per cent on the investment; whereas, if the machine were in constant use, the corresponding rate would be 30 per cent.

Now, 8 per cent on each $1,000 of investment is $80 a year, which is a sum so small that it may be saved several times over in a month. This fact is likely to be impressed on any one who will take the pains to calculate the cost per cubic yard of backfill tamped by hand, wages being $2.50 to $3 a day, and workmen leisurely playing the part of weight lifters.

Water Tanks Made of Cement Plaster and Metal Lath

Some fifteen years ago a mining engineer described a large smoke conduit for a smelter, which was made by plastering cement mortar on metal lath. No forms were required and a very economical flue was produced. We mention this merely to indicate one of the many ways in which plastered metal can be used.

A water tank 14.6 ft. in diameter, and 14 ft. high was built by erecting wooden studs, to which were fastened wire mesh and metal laths, that were given several coats of cement plaster (1 to 2½ mix) containing cattle hair and 10 per cent of hydrated lime. The cement wall of the tank was made 5 in. thick at the top and 7 in. at the bottom. Each coat of mortar was scratched as soon as it was sufficiently hard. The final inside coat was floated and a wash of neat cement and hydrated lime applied with a brush. The floor of the tank was concrete containing hydrated lime.

Considering the facility and economy with which structures of plastered metal lath can be made, it is surprising that more of them are not built.

Unit Cost of Sewer Construction at Providence, R. I., in 1916.

During 1916 about 19,000 lin. ft. of 8 in. to 30 in. sewer constructed for the city of Providence, R. I. The accompanying tabulation, from the last annual report of M. H. Bronsdon, City Engineer, shows the average depth of cut, nature of excavation, and contract cost of labor per foot, on the different sizes of regular sewers built during last year:

Items.	Average Nature of Excavation.	Av. depth of cut. Ft.	Av. cost per ft.
6-in. pipe in drains to curb line	Sand and gravel, dry	10.50	$0.58
6-in. pipe in drains to curb line	Fine sand, dry	10.50	.57
6-in. pipe in drains to curb line	Fine sand, wet	10.50	.75
6-in. pipe in drains to curb line	Sand, gravel & boulders	10.50	.51
6-in. pipe in drains to curb line	Hard pan	10.50	.62
6-in. pipe in drains to curb line	Rock	10.50	2.18
8-in. pipe in basin connections	Fine sand, dry	8.00	.49
8-in. pipe in basin connections	Fine sand, wet	8.00	1.00
8-in. pipe in basin connections	Sand and gravel, dry	8.00	.67
8-in. pipe in basin connections	Sand, gravel & boulders	8.00	.45
8-in. pipe in basin connections	Hard pan	8.00	.66
8-in. pipe in basin connections	Rock	8.00	.50
12-in. pipe sewer	Sand and gravel, dry	12.00	1.23
12-in. pipe sewer	Fine sand, dry	12.00	1.01
12-in. pipe sewer	Fine sand, wet	12.00	1.00
12-in. pipe sewer	Sand, gravel & boulders	12.00	1.00
12-in pipe sewer	Hard pan	12.00	1.68
12-in. pipe sewer	Rock	12.00	2.10
15-in. pipe sewer	Sand and gravel, dry	12.25	1.25
15-in. pipe sewer	Fine sand, dry	12.25	1.00
15-in. pipe sewer	Fine sand, wet	12.25	3.00
15-in. pipe sewer	Hard pan	12.25	1.38
16-in. circular brick sewer	Sand and gravel, dry	12.33	2.40
16-in. circular brick sewer	Fine sand, wet	21.75	6.75
20-in. circular brick sewer	Sand, gravel & boulders	12.67	2.00
20-in. circular brick sewer	Hard pan and rock	12.67	3.20
24-in. circular brick sewer	Sand, gravel & boulders	13.00	2.00
24-in. circular brick sewer	Sand and gravel, dry	13.00	2.75
28-in. circular brick sewer	Sand, gravel & boulders	13.33	3.00
30-in. circular brick sewer	Sand and gravel, dry	13.50	3.00

Methods and Costs of Constructing 4,173 Feet of Large Concrete Sewer

BY E. T. THURSTON.
M. Am. Soc. C. E., 57 Post St., San Francisco, Cal.

The work consisted of the complete construction of 450 ft. of 8-ft. 6-in. x 9-ft. standard horseshoe section, reinforced concrete sewer, 100 ft. 8-ft. 6-in. x 9-ft. extra-heavy, horseshoe section, reinforced concrete sewer under a 4--track main line railroad crossing, 908 ft. 7-ft. 6-in. diameter, circular-section, reinforced concrete sewer with vitrified brick invert, and 2,695 ft. 5-ft. 2-in. x 7-ft. 9-in. egg-shape, reinforced concrete sewer with brick invert (including a 90° curve of 21 ft. radius and two 10-ft. taper sections connecting the respective standard sections), representing a total length of 4,173 ft. of sewer. Auxiliary structures comprising 18 standard brick manholes, 26 concrete catch basins and catch-basin connections consisting of 79 ft. of 18-in. vitrified pipe and 1,724 ft. of 12-in. vitrified pipe are not included. The sewer for most of its length runs in a 100-ft. street, its center line being located 22 ft. from the center line of the street, and from 8 to 10 ft. from the center line of a single-track electric street railway, the operation of which was suspended during construction. The required excavation was from 9 ft. to 20 ft. 6 in. deep, averaging 15 ft. 3 in.

For the first 1,000 ft. the excavation averaged 12 ft. in depth through a layer of heavy, black gumbo about 6 ft. thick, overlying black, muddy silt carrying considerable water and in places approximating quicksand. The conditions required close sheeting and heavy timbering and much trouble was had with sloughing sides and seeping water. This changed gradually to stiff yellow clay mixed with black gumbo overlying water-bearing gravel and finally to very stiff yellow clay, difficult for the steam shovel to handle without the assistance of its crowding engine. For two-thirds the length of the trench the ground required constant attention and careful shoring to ensure against cave-ins. Ten street intersections were crossed, six of which carried live sewers and water mains and one carried a 4-track, main-line railroad, one a 2-track interurban railroad and one a 3-track electric street railway, a concrete sewer culvert and a network of heavy water mains. The work was commenced in the middle of March, 1914, and was completed with the end of October, 1914.

Organization and Equipment.—The original working equipment consisted of a steam shovel, two concrete mixers supported on trucks, charging barrows, concrete hoppers and chutes, 2-yd. dump wagons, slip scrapers, 2 diaphragm pumps, 1 gas-driven centrifugal pump and miscellaneous small tools such as shovels, picks, mattocks, German hoes, etc. A locomotive crane with equipment of dump buckets was added later as will be noted.

The working force consisted of a superintendent, a time-keeper, an engineer, 6 foremen (overseeing respectively the finishing of the excavation, the shoring and lagging of the trench, the concrete work, the steel reinforcement, the handling of forms and the extra gang constructing catch-basins and outlying manholes and connections with same, gutters, curbs, etc.), the steam shovel crew, a general mechanic, carpenters and laborers; to which was subsequently added an engineer and a signal-man for the locomotive crane.

The superintendent had active general charge of the work, assisted in an expert capacity by the engineer, who in addition attended to overseeing the manufacture and handling of the forms and the bending of steel reinforcement, the forms being designed at the main office, the ribs sawed out to order in a planing mill and the forms made up on the job. Had it not been impossible at the commencement of the work to secure a general superintendent that was competent to read and interpret plans and specifications, the engineer would not have been necessary, and during the latter half of the work his services were dispensed with.

The timekeeper kept a carefully segregated record of time, employing a mnemonic system of record and making four round trips per day over the entire work to secure a classified record. He also assisted in keeping track of materials and supplies and made out and forwarded the superintendent's daily report to the head office.

The excavation foreman had charge of a gang of about 30 laborers which followed the steam shovel, shored or lagged the trench, finished the trench to size, line and grade by templet, excavated street crossings and installed the underdrains. The excavated material was handled out of the ditch by stages.

The concrete foreman supervised the work of a gang of 10 men mixing and placing concrete and assisting the foreman carpenter in handling the forms.

The steel foreman had one or two assistants and when not engaged in placing reinforcement the gang was kept fairly busy bending it into the shape required.

The foreman in charge of the extra gang had a dozen or more men, depending on the demands of the more important part of the general work.

General Plan of Operation.—This required that the finishing gang keep close behind the steam shovel, but owing to the fact that the latter was limited in depth of cut to about 16 ft. and as the ground was of an extremely unstable nature and the excavated material very wet and difficult to handle, it was found impossible even approximately to follow this plan. The fact that the street crossings had to be excavated entirely by hand also delayed the progress of the finishing gang. For this reason the numerous delays in the steam-shovel work really retarded the general progress very little. At one time the shovel was 850 ft. ahead of the finishing gang. Fortunately the labor strike occurred at this time and therefore did not affect the progress of the work as a whole.

After the trench had been finished to exact size and underdrain installed, the invert reinforcement was placed, then the invert forms, after which the first of the two mixers was moved into place and the invert poured. At the expiration of two days the forms were removed and the brick invert, if any was required, laid, after which the arch reinforcement was placed; then the arch forms set in place and braced, and the balance of the concrete poured with the second mixer. The sides were poured first and after the concrete had set the wing forms were adjusted and braced and the top poured, the sides and arch generally, but not necessarily, being poured on different days.

After sufficient time, in the opinion of the inspectors, had elapsed, generally about a week, backfilling was proceeded with by means of a team with slip scraper, driver and holder, scraping into the trench that portion of the excavated material that had been dumped alongside for that purpose. The loose fill being thus completed up to within about a foot of the surface of the ground, the whole ditch was flooded, the water being introduced at the surface of the concrete through a long pipe inserted into the ground. As much as possible of the balance of the fill to bring the trench up to subgrade was done by team direct from the steam-shovel excavation. The trench being thus filled practically to the level of the pavement it was left until near the end of the job when the entire work of repaving was done as one job.

Excavation.—The main excavation was done with a steam shovel mounted on trussed cross-timbers supported on hardwood rollers running on boards laid on either side of the proposed trench, spanning about 20 ft. on centers, the outfit pulling itself along as required by means of a cable attached to a deadman ahead. The shovel was especially equipped with a 1-cu. yd. dipper on a long dipper stick enabling it as mounted to dig about 16 ft. below grade.

The outfit, assembled as described, just at it had been returned from a similar job some 3 years before was rented for $250 per month on the assurance that the boiler and engine, though dirty and rusty, were in good working order, the boiler having received new tubes just before it was laid up in the yard. Two days overhauling and inspection by a complete crew and the contractor's supervising engineer resulted in a favorable report on the shovel, but, within the rental period, the boiler tubes were rerolled until they had to be reinforced, the boiler required sheathing and a new idler pulley, new bronze gear pinion, new friction strap and shoes, and ultimately an entire renewal of the crowding engine were necessary. Minor troubles, such as chain breakage, were of about daily occurrence and probably doubled the reasonable cost of operation.

Rental was paid for 161 calendar days. Of these, 22 days were required in moving from storage to job and return; 20 days were holidays or rainy days and 15 days were lost on account of jurisdictional disputes between labor unions, leaving 104 days available for actual work. Of these 104 working days 37 were devoted wholly to repairs and renewals, leaving only 67 days or 64 per cent of the working time or 41½ per cent of total time on which actual excavation, together with incidental repairing, was done.

Sufficient material for backfilling was piled on one side of the trench and the balance of the excavated material was dumped direct into wagons moving on the other side. In addition to the shovel crew, three attendants were in general required for miscellaneous work, principally keeping street clean around wagons, watching trench banks for signs of failure, planting and shifting deadmen and attending rollers while moving ahead. Owing to the structural limitations of the machine and the weakness or entire uselessness of the crowding engine, which limited the control and power of the dipper, the cut was not carried as close as desirable to the finish lines on the sides and bottom, and an average of about 6 in. on either side and from 6 in. to 5 ft. in the bottom was left for the finishing gang to remove.

The trench as dug by the shovel varied from 12 ft. to 7 ft. wide and from 7 ft. to 15½ ft. deep, and the material, as hereinbefore stated, was mostly black gumbo and sandy clay, easy digging except in the last quarter of the work, where stiff, sandy clay, merging into hardpan, was encountered, and with a crippled crowding engine the digging was found difficult.

The shovel crew, working 8 hours per day, 6 days per week, with time-and-a-half allowance for overtime and double time for working Sundays and holidays, comprised the following:

	Per day and board.
1 steam shovel engineer	$6.00
1 cranesman	4.25
1 fireman	3.00
3 laborer attendants	2.50

Coal was $9.00 per ton delivered.

Following is a statement of the performance of the steam shovel:

STEAM SHOVEL PERFORMANCE.

	Days.	Mat'l.	Labor.	Total.	Per cu. yd.
Investigating outfit	4½	$.....	$70	$70	$.....
Moving on and off job—					
Moving ¼ mile and loading on car	5	42	318	350	......
Unloading and setting up on job	5½	7	110	117	......
Freight both ways	5	60	......	60	......
Moving off job ¼ mile and loading on car	3½	7	130	137	......
Unloading and returning ¼ mile to owner	3	......	100	100	......
Compensation insurance on labor	...	40	......	40	......
Totals for moving	22	$156	$658	$814	$0.063
Operation—					
Rental and labor	161	$1,356	$1,494	$2,850	$0.228
Fuel and oil (coal at $9 per ton)	..	1,063	......	1,063	0.082
Compensation insurance	..	113	......	113	0.008
Repairs and renewals	37	256	474	728	0.056
Total operation cost	67	$2,788	$1,966	$4,754	$0.366

Note.—Quantity of material handled (13,000 cu. yd.) is given as originally estimated necessary to be done and takes no account of extra material handled because of slides and failure of banks.

The best day's performance of the shovel was 109 lin. ft. of trench or about 345 cu. yd. excavating to a depth of about 12 ft. 6 in. Toward the end of the job, while excavating to its maximum depth of 16 ft., its best day's work was 60 ft. of trench or 220 cu. yd. The shovel averaged 194 cu. yd. for each day in which digging was done and 125 cu. yd. for each available working day. In considering the performance record it should be borne in mind that the necessity for storing a portion of the excavated material along the trench for subsequent backfill enabled the shovel to keep at work regardless of whether the dump wagons were spotted promptly for loading, thus materially reducing what is usually the controlling factor in steam-shovel output.

Hand Excavation and Trimming.—The finishing gang with picks, shovels, German hoes and mattocks, did all the excavation left by the steam shovel, and finished the trench carefully to size, shape, line and grade and laid an underdrain of 4-in. tile covered with gravel which carried the seepage water to sumps constructed at intervals of about 600 ft., which in turn were relieved by an electrically operated, 2-in. centrifugal pump, tended chiefly by the general mechanic. During the first two months the gang comprised about 30 laborers at $2.50 per day (8 hours), a straw boss and interpreter (Italian) at $3.75, and a foreman at $5. The excavated material was shoveled by stages to the surface of the ground and thence into wagons. This portion of the work in particular was in very wet ground, necessitating the construction of dams of sacks of sand and the use of a 2-in. centrifugal pump and a 3-in. diaphragm pump. Latterly, a 5-ton locomotive crane with outfit of dump buckets was secured and mounted on the street car track alongside the trench, greatly facilitating the work, as will appear from the tabulated statement of cost. It should be considered, however, that there was less mud to contend with in the portion of the trench served by the crane.

Preceding the finishing gang and immediately behind the steam shovel, a lagging gang of from 2 to 5 men at $2.50 and $2.75 per day, under a foreman at $4 per day, placed necessary shoring and lagging. The bracing, where sheeting, was required, comprised 2 lines of 6x8 rangers on either side with 6x8 spreaders on 6 to 8-ft. centers and 2-in. x 12-in. sheeting was driven behind these rangers, a total of 29,000 ft. B. M.; 2-in. plank was used for this lagging, very little of which was recovered intact. In addition 16,000 ft. B. M. Oregon pine lumber were used for rangers, spreaders, etc.

The total cost of deepening and finishing trenches to templet after rough work had been done by the steam shovel (except at street crossings which the shovel had to skip and which, therefore, was all hand work) and depositing material either in spoil bank or in wagons (except the section through unimproved street, which was all hand work under superior working conditions and from which all material was spoiled along the trench) was as follows, laborers receiving $2.50 and $2.75 per day and foreman $3 per day:

	Quantity, cu. yd.	Mat'l.	Labor.	Total.	Per cu. yd.
Hand work, by stages	1,800	$.....	$4,382	$4,382	$2.43
Hand work, crane and bucket	3,100	766	3,059	3,825	1.23
Hand work, by stages, through unimproved street	1,700	......	1,553	1,553	.92
Tools, etc.	.....	422	58	480	.....
Total	6,600	$1,188	$9,052	$10,240	$1.55

The performance of the crane alone is summarized as follows, engineer on crane receiving $6 per day and signalman $5 per day:

	Mat'l.	Labor.	Total.	Per cu. yd.
Rent, crane (96 days)	$624	....	$ 624	$0.201
Rent, buckets	63	....	63	.020
Freight and cartage	15	....	15	.005
Renewals and repairs	9	$ 37	36	.012
Fuel, oil, etc.	55	....	55	.018
Crew (engineer and signalman)	...	854	854	.276
Compensation insurance	69	....	69	.022
Total (3,100 cu. yd. handled.)	$835	$891	$1,726	$0.556

Forms.—The forms for invert, sides and arch of each standard section were constructed of 1½-in. solid and 1¾-in. and 2¾-in. built-up ribs, and 1x3 and 1x6 tongue and groove sheathing. The ribs were sawn to detail, delivered from mill to job in the knockdown and there, with sheathing, assembled into units. The invert units were made in one piece, but those of the arch in three pieces designed to collapse on removal of separator at bottom and be moved forward in sections. The arch and invert forms for the two 10-ft. taper sections, joining sewers of different shape and size, were built in place on ribs delivered sawn to detail. The forms for a 90° bend of 21-ft. radius were assembled and built in three sections comprising arch and sides intact, and three invert sections, on ribs taken from discarded straight units, and lowered into place bodily.

The forms for the 8-ft. 6-in. x 9-ft. horseshoe-shape and the 7-ft. 6-in. circular sewers were made in units 10 ft. long, but these were found too bulky and the forms for the arch and sides of the 5-ft. 9-in. x 7-ft. 6-in. egg-shape sewer were therefore made in 8-ft. units; 200 ft. of arch and 100 ft. of invert forms were made for the horseshoe-shape sewer, 200 ft. of arch and invert forms for the circular sewer, and 320 ft. arch and 100-ft. invert forms for the egg-shape sewer. The quantity was about right for the last-named, but turned out to be excessive by about 50 per cent for the others, due to erroneous anticipation of working conditions. The mill work on these built-up ribs cost about $23 per M ft. and on the solid ribs $10 per M ft.

The labor cost per foot of sewer built was as follows, carpenter's wages averaging $3.50 per day:

Making forms, exclusive of millwork, 10.2 ct.; placing and removing forms 51.6 ct.; making, placing and stripping forms for curve, $8.52 per foot. The forms were greased with crude oil to facilitate stripping and the abutting ribs of adjoining sections were connected by special bolts with loose threads and thumb nuts, thus largely obviating the use of wrenches and accelerating the work of stripping and erecting.

The wing or outer arch forms for the horseshoe and circular sewers were made up in 10-ft. lengths of sheet steel reinforced with flat bars, sufficient to form 50 ft. of sewer. It was considered that these forms, which were so made as to be adjustable, by rebending over a form, to suit the varying extradosal curvature, would serve the entire job, but they proved somewhat awkward to handle and were not used for the egg-shape sewer, wooden forms being substituted. Here, it may be observed, the contractor found the supervising inspector desirous that the extrados present a uniform, smooth surface, although it was doomed forever to be covered from view under several feet of earth and macadam, and some difficulty was experienced in avoiding giving it a troweled plaster finish.

Reinforcement.—The specifications provided for reinforcement with electrically-welded wire fabric No. 3 and No. 8 wires, 2-in. x 16-in. mesh for the horseshoe sewer; No. 3 and No. 10 wire, 2-in. x 16-in. mesh for the round sewer, and No. 3 and No. 10 wires, 3-in. x 16-in. mesh for the egg-shape sewer. Inasmuch as it was required that two-thirds of the stone or coarse aggregate should pass a 2-in. screen and be rejected on a 1¼-in. screen, the contractor foresaw difficulty in using the 2-in. mesh frabric and induced the engineer to consent to the substitution of deformed bars of medium steel, provided the reinforcement have at least equivalent strength, figuring the wire at 60,000 lb. per square inch and the bars at 16,000 lb. per square inch.

The bars were bent to templet in the material yard close by and brought to the job ready to place. To avoid treading the invert reinforcement into the mud at the bottom of the trench, it was necessary to lay boards in the bottom and to tie the bars to position after the invert forms were in place, after which the boards were removed. The arch reinforcement was placed before the forms were set and rigidly tied and braced to position. In planning the reinforcement, the contractor made special provision in the bending to facilitate placing and retaining the bars in exact position under the plan when the ends of the invert bars rested against the sides of the trench (or exterior limit of concrete) at a fixed elevation, the bars were in exact position. The arch bars were required to be bent slightly but sharply 18 in. from each end so that when wired at the angle points to the invert bars they also were in exact position. This expedient was noticeably effective in speeding up the work. In all 174,300 lb. of reinforcing steel was used, averaging 56.4 lb. per cubic yard concrete, and cost to handle 68 ct. per 100 lb., with labor averaging $2.87½ per day.

Concrete.—The specifications provided: "All concrete used in the work shall be composed of Portland cement, sand and broken rock or cement and gravel in the proportion of 1 cu. ft. of cement to 2 cu. ft. of sand and 4 cu. ft. of stone." An attempt was made by the contractor to use for the aggregate a mechanically graded mixture of gravel and sand delivered ready mixed on the job, but inasmuch as conformity to exact proportions for maximum density as established by laboratory analysis of sampled material was insisted upon and permission to order a mixture having a slight excess of sand, to allow for inevitable loss of fine aggregate, refused, the attempt was abandoned in favor of separate aggregates proportioned on the job.

The contractor's choice of a concrete plant was governed by the experience of another contractor on a similar job in a nearby locality and by the fact that a complete outfit of two mixers mounted on crosstimbers, with gas-engine power, trucks and rails complete, was ready to hand at a fair rental. The rails were laid on heavy longitudinal timbers on either side of the trench and the mixers mounted directly over the center of the sewer. One mixer was placed ahead to pour invert and the other followed to pour the arch. This plan was adopted to avoid delay involved in moving the heavy machinery back and forth, for the invert progressed at times 200 ft. ahead of the arch.

The outfit was expensive to install, this item amounting to about $300, and difficult and expensive to move, requiring the entire concrete gang, a team of horses and the undivided attention of the superintendent to accomplish, gave frequent trouble and often flatly refused to perform at critical moments; and the splashing and dripping of the concrete out of the mixer on the workmen beneath rendered the working conditions decidedly unsatisfactory. After three months of trying experience, a new 12-cu. ft. mixer on trucks and equipped with side loader and electric motor was substituted. The new outfit worked alongside the trench and delivered the concrete to the forms by means of open metal chutes. It was specially fitted to be operated, fore and aft, by one man, was easily moved and the labor cost of mixing and placing the concrete was thereby reduced 40 per cent. The progress of the concreting was not chiefly dependent on the capacity of the plant, but on the advancement of other portions of the work, mainly the preparation of the trench.

The forecasting of the work was assisted by the following table (Table I) of roughly approximate unit quantities, from which delivery and placement of material was determined and performance of the gang judged during the progress of the work.

TABLE I.—APPROXIMATE UNIT QUANTITIES.

Type.	8′ 6″ x 9′ 0″. Standard.		8′ 6″ x 9′ 0″. Heavy.		7′ 6″ cir.		5′ 2″ x 7′ 9″.	
Total length, including taper sections	450 ft.		105 ft.		918 ft.		2,700 ft.	
	Invert.	Arch.	Invert.	Arch.	Invert.	Arch.	Invert.	Arch.
Concrete per ft., cu. yd.	.315	.685	.430	1.000	.185	.630	.148	.500
Rock, per ft., 85 cu. yd.	.27	.58	.37	.85	.16	.53	.13	.43
Sand, per ft., 43 cu. yd.	.14	.29	.19	.43	.08	.27	.07	.22
Cement, 1.84 bbl.	.45	.98	.62	1.44	.27	.91	.21	.72
Rock, per 25 ft., cu. yd.	7	15	9	21	4	13	3	11
Sand, per 25 ft., cu. yd.	3	7	5	11	2	7	2	6
Cement, per 25 ft., bbl.	12	25	16	36	7	23	5	13

The cost of the concrete work done by each outfit is shown in the following statement:

Old Mixers:	Material.	Labor.	Total.
Rent	$ 502.00	$........	$ 502.00
Freight and cartage	60.00	157.00	217.00
Repairs and equipment	102.00	36.00	138.00
Gasoline	53.00	....	53.00
Small tools (½ total)	37.00	....	37.00
Plant expense	$ 754.00	$ 193.00	$ 947.00
Concrete (1,405 cu. yd.)	6,930.00	2,241.00	9,171.00
Totals	$7,684.00	$2,434.00	$10,118.00
Totals per cu. yd.	5.47	1.73	7.20
New Mixer:			
Depreciation	$ 400.00	....	$ 400.00
Equipment	81.00	$ 33.00	114.00
Small tools (½ total)	38.00	....	38.00
Freight and cartage	13.00	28.00	41.00
Motor rent and installation	57.00	....	57.00
Power	35.00	....	35.00
Plant expense	$ 624.00	$ 61.00	$ 685.00
Concrete (1,686 cu. yd.)	8,317.00	1,598.00	9,915.00
Totals	$8,941.00	$1,659.00	$10,600.00
Totals per cu. yd.	5.31	0.98	6.29

The average concrete gang on the original outfit numbered 10 laborers at $2.75 per day, 1 mixerman at $3 and 1 foreman at $5; on the new outfit, 6 laborers at $2.75, 2 men at $3 each and 1 foreman at $5, the latter being displaced ultimately by one of the $3 men raised to $3.50. It may be noted that the labor cost of mixing and placing concrete was 95 ct. under the new arrangement, against $1.59 under the old.

The largest day's concrete work with the old mixers included about 60 ft. of invert and 50 ft. of arch, the invert being 350 ft. in advance of the arch at this stage; 64½ bbls. of cement were used, indicating 43 cu. yd. concrete and the labor was as follows:

1 foreman at $5	$ 5.00
2 laborers at $3	6.00
10 laborers at $2.75	27.00*
Total labor	$38.50

*Or $0.90 per cu. yd.

The largest day's concrete work with the new mixer comprised about 79 ft. of complete arch and 97 ft. of sides only, the work extending over a distance of 176 ft. of sewer; 98¾ bbls. of cement was used, indicating 66 cu. yd. concrete and the labor was as follows:

1 foreman at $5	$ 5.00
2 laborers at $3	6.00
6 laborers at $2.75	16.50
2 laborers at $2.50	5.00
Total labor	$32.50*

*Or $0.50 per cu. yd.

In each of the foregoing instances, conditions were favorable for rapid work, which consumed an entire day of 8 hours with the men working for a record. Concrete was poured on 62 days by the former plant and 71 days by the latter plant, the average outputs being 22.6 cu. yd. and 23.8 cu. yd., respectively, per day worked.

Cement cost $2.375 per barrel delivered in sacks, with an allowance of 10 ct. each for empty sacks returned in acceptable condition (about 70 per cent of total); sand and gravel $1.40 per cubic yard delivered; water at 7 ct. per cubic yard of concrete—all included in cost of concrete materials as it appears in the statement. The statement covers cost of patching, applying the cement wash specified for the interior and final cleaning out of the sewer in preparation for minute and official inspection.

Brick Lining of Invert.—The invert of the circular and egg-shape sewers was lined with vitrified paving brick, laid flat in mortar composed of 1 part Portland cement to 2 parts quartz sand. This work, necessarily intermittent, had an important influence on the progress of the job, rendering speed, reliability and expertness on the part of the men especially desirable. Slowness or unavailability on call meant direct delay, and an uneven lining would greatly increase the difficulty of making a tight joint between the side arch forms and the invert. The brick mason on this work was paid $8 per day, his hodcarrier $5, and a laborer helper $2.75 for 8 hours' work. The bricks were first piled along either side on the haunch of the invert against the reinforcing bars, and then the surface of the concrete swept and flushed clean and dusted with cement. The hodcarrier mixed the mortar as required and generally assisted the mason, while the laborer kept them supplied with material from above. The labor cost of laying the invert was 4 ct. per square foot, or about $10 per 1,000 brick. Although the wages paid the mason and hodcarrier involved an advance of $1.00 each per day over the standard wages for high-grade workmen, the results are deemed amply to have warranted the extra expense.

Backfilling.—The backfilling was accomplished in part by wagon dump direct from the steam-shovel or other excavation, and in part by shoveling and scraping from the spoil bank left on one side of the trench, using a slip scraper, team and driver at $6.00 per day with generally two men at $2.50 and $2.75 per day to handle the scraper. The trench was filled to a crown as soon as convenient after completion of concrete, puddled by introducing water at the bottom through a pipe attached to the end of a hose and inserted in the ground and allowing to run until water appeared on the surface of the sunken fill, after which it was allowed to stand and partially dry out before adding more fill. Water for this purpose was charged at the rate of 0.7 ct. per lineal foot of trench puddled. It was only after some experimenting and considerable argument that the contractor was permitted to proceed in this manner, for the specifications prescribed tamping in layers; but the method allowed proved very satisfactory. It is estimated that about 8,200 cu. yd. compacted fill was required at a special labor cost of about 26 ct. per cubic yard, which of course ignores the work of the teams that worked directly between the excavation and the backfill. A large portion of this expense, amounting to 10.8 ct. per cubic yard of excavated material, or nearly 10 per cent of the unusually high cost of all the trench work, would not obtain in a well co-ordinated job.

Repaving.—The specifications for repaving contained what the contractor termed a "joker"; for in addition to providing as usual that the pavement where disturbed should be restored to its original condition, it was further provided "That no pavement shall be laid on a foundation of less than 4 ins. of gravel or broken stone **below the original pavement.**" As the pavement was oil macadam of substantially its original thickness of 5 to 6 ins., this meant the somewhat unusual thickness for macadam in this locality of from 9 to 10 ins. Coarse gravel being cheaper than macadam rock, the contractor, with the consent of the engineer, innocently chose the former for the underlying ballast; somewhat to his sorrow, however, for not until it had been plentifully fed with screenings did it form a stable bed for the macadam proper.

The sub-grade was trimmed by hand to show a slight crown and vertical edges and compacted by means of a horse roller, followed by 5 and 10-ton steam and gasoline rollers. The gravel ballast was delivered by rail in gondola cars on a siding about ½ mile average haul from the work. It was unloaded by hand direct into bottom dump wagons, deposited on the subgrade in piles, spread by scrapers, finished with shovels and rolled to a level surface to receive the macadam. The cost of preparing the subgrade was approximately ¾ ct. per square foot, and of spreading and finishing the ballast ½ ct. per square foot.

Hauling of Material by Motor Truck.—The bulk of the macadam rock and screenings was delivered by barges holding from 250 to 350 cu. yd. and equipped with a combination belt-and-bucket conveying system for unloading and discharging into a small wharf bunker of about 15 cu. yd. capacity from which 5-yd. auto trucks were loaded in less than 1 minute. The discharging capacity of the barge machinery was about 1¼ cu. yd. per minute. The hauling of the macadam material was contracted at 30 ct. per cubic yard, but some record was kept of the performance of the trucks which may be of interest.

The first barge-load of 274 cu. yd. was hauled during one day by three good trucks, two 5-yd. and one 4-yd., averaging about three trips per hour. The standard charges for motor-truck service were $25 and $30 per 9 hours work for 4-yd. and 5-yd. trucks, respectively, or say 69 ct. per cubic yard capacity per hour. At this rate, if the trucks had been hired by the day, and had given the employer equally good service, the cost of the hauling would have been 23 ct. per cubic yard.

The second barge-load was, owing to unavailability of adequate motor-truck service during the daytime, hauled between 3:00 p. m. and 2:00 a. m., commencing with one 4-yard truck, to which others were added from time to time until ultimately three 4-yd. and four 5-yd. trucks were in commission. For the three 4-yd. trucks, the total truck hours on the job were 23.33, of which 7.5 were time lost in intervals of 1 hour or more on account of breakdowns or necessity of the drivers, leaving the actual working time, including minor incidental delays, 15.83 hours during which they hauled 132 cu. yd. At the standard service rate this would represent a cost of 33.4 ct. per cubic yard. For the four 5-yd. trucks, the total truck hours were 29.25, of which 20 truck hours represented legitimate work during which they hauled 220 cu. yd., which would have cost at the standard service rate 30¼ ct. per cubic yard.

In addition to the inconvenience of working at night, some of these trucks were not in the best of condition, nor were all the drivers expert. Their variable performance is indicated by the fact that the average times per round trip for the three 4-yd. trucks were 24, 30 and 31 minutes, and for the four 5-yd. trucks, 21, 27, 29 and 32 minutes, respectively. The haul of this barge-load averaged about 1½ miles.

Macadamizing.—The macadam rock was for the most part dumped on the ballast, the truck moving ahead while dumping, adjusting the speed so as to effect as nearly as might be the proper distribution of the rock along the trench. Where the rock was left in piles it was spread by means of a fresno scraper and the entire surface of the work in place was finished by laborer with shovels and potato hooks. The screenings were then shoveled over the entire surface sufficient almost to cover all the rock, well sprinkled and rolled successively with a 5-ton and a 10-ton steam or 12-ton gasoline roller. Accompanying the roller, a laborer spread additional screenings to fill the principal surface voids. Road oil was then applied to the specified amount of ¾ gal. per square yard, on which immediately were spread screenings and rolled to a compact surface, rescreening as required to take up all surplus oil.

The cost of spreading the macadam rock and screenings as aforedescribed was 42½ ct. per cubic yard, or nearly 1 ct. per square foot of pavement, with labor at $2.50 and team and driver at $6 per day of eight hours.

The 5-ton roller was rented at $7 per day, the engineer was paid $6 and between $3 and $4 per day was expended for fuel. The 10-ton roller, including engineer and fuel, was rented at $2.50 per hour, and the 12-ton roller at $1.90 per hour, including engineer and fuel. The total cost of the rolling, including subgrade and oiled surface, amounted to about 0.6 ct. per square foot.

The oil was furnished and spread with a standard spraying machine by contract with a local paving contractor at $2 per barrel spread. (Hot oil at retort being quoted at $1.65 per barrel.)

Insurance.—The item of employes' compensation insurance is a considerable one in this class of work, the premium rate being high and many companies refusing to take the risk on deep sewer work. The manual rate, endorsed by the State Insurance Fund, was 14.03 per cent of the payroll, although the company insuring the job cut this rate to 7.72 per cent. Every precaution was taken to avoid accident with the result that only one man was injured sufficiently to require unusual attention or to incapacitate him for work for more than a few hours. This man had two of his fingers crushed between a rising dump-bucket

TABLE II.—SUMMARY OF COST.

	Total costs		Unit costs		
	Material, tools, etc.	Labor.	Mat'l, etc.	Labor.	Comb'd.
Excavation and backfill, 19,600 cu. yd	....	....	....	....	$1.138
By steam shovel, 13,000 cu. yd	$2,944	$2,694	$ .226	$ .207	......
By teaming, 13,000 cu. yd	....	908	....	....	......
By hand, 6,600 cu. yd	1,188	9,052	.180	1.370	......
By teaming, 6,600 cu. yd	....	679	....	....	......
Unwatering, 6,600 cu. yd	214	543	....	....	......
Bracing and lagging, 45,000 M. ft. B. M.	822	1,026	18.27	22.80	......
Backfilling, 82,000 cu. yd	28	1,531	.003	.186	......
Teaming, 82,000 cu. yd	....	581	....	.071	......
Forms, 4,142 lin. ft	....	....	.37	.68	1.05
Making—Std. sec., 650 lin. ft	1.400	422	2.15	0.65	......
Handling—Std. sec., 4,142 lin. ft	19	2,135	....	.52	......
All work on curve, 31 lin. ft	......	264	....	8.52	......
Steel top forms, 50 lin. ft	117	....	2.34	....	......
Reinforcement, 87.15 ton	....	....	....	....	45.70
Bars and bending, 87.15 ton	2,774	438	21.70	5.03	......
Placing, 87.15 ton	31	753	.35	8.62	......
Concrete, 3,091 cu. yd	16,625	4,093	5.40	1.32	6.72
Brick invert lining, 12,690 sq. ft	....	....	.122	.040	.162
Vitrified brick, 50.481 M bricks	1,278	501	25.25	9.92	......
Mortar, 50.481 M bricks	261	....	5.15	....	......
Oil macadam, 390 squares	......	....	5.17	2.15	7.72
Subgrade and ballast, 390 cu. yd	310	478	.79	1.22	......
Macadam and screenings, 958 cu. yd	1,328	363	1.39	.38	......
Rolling, 393 squares	232	....	.59	....	......
Oiling, 390 squares	147	....	.38	....	......
Superintendent, timekeeper, engineer and miscellaneous	830	3,304	104.00	413.00	......
Compensation insurance, 9 months	.....	1,731	2¾%	12½%	......
Totals	$30,558	$31,496	......	....	......

and a trench timber, because he did not let go when told to, necessitating their amputation. However, out of this experience the insurance company figured a "loss ratio" of over 70 per cent, and reported their experience with the risk "very unsatisfactory." Assuming the apparent fact that the proper proportion of all the expense of the company was charged against this risk, one is led to envy the business that looks upon a net profit of upwards of 30 per cent as unsatisfactory; and any other assumption would, in view of the unusually light accident record of this job, render it inconceivable that insurance companies could continue to insure against compensation liability on sewer work and remain solvent.

Remarks.—The contract for the work was signed March 4, 1914, and allowed 180 calendar days, or until Sept. 1st, for completion. Excavation commenced March 19th, and the work was cleaned up and completed Oct. 27, 1914, a total of time of 237 calendar days, or nearly 8 months. Although not more than 5 days were lost on account of rain, the contractor was not penalized, due consideration being given to the unforeseen subsurface conditions encountered and the labor troubles referred to in discussion of the steam-shovel work.

Averaged for 8 months duration of work, the general expense, inclusive of overhead, amounted to $104 for material, and $413 for labor per month, or 2¾ per cent and 12½ per cent of the respective net totals excluding insurance. The fact that this total general expense amounted to 15¼ per cent of the actual cost of material and labor is interesting in view of the engineer's interpretation of the contract provision that extra work should be paid for at "actual cost as estimated by the City Engineer" (making no allowance for the use of tools, plant or general superintendence) "plus 15 per cent for profit." Under the engineer's interpretation the contractor was not permitted to apportion any of the time of the superintendent, timekeeper, or other miscellaneous expense, to extra work. It is a not uncommon notion of engineers and architects that a 15 per cent, or even a 10 per cent, allowance, over and above actual cost of labor and material, is ample to cover general expense and profit on extra work. As a rule extra work imposes on the contractor trouble and expense out of proportion to the average for the job and the fact cannot be too clearly impressed upon the minds of engineers and architects that it is this general annoyance and expense that entitles him to a fair, clear profit over all estimable items of expense entering into the work.

Garbage Disposal by Incineration, Reduction and Feeding to Swine

Important facts concerning garbage disposal methods and costs in various cities are given in a recent report prepared by the Springfield Bureau of Municipal Research of Springfield, Mass. The main features of the report regarding the various methods of disposing of garbage follow:

Incineration.

Fuel Used in Incineration.—By incineration is meant the disposal of garbage by burning. The fuel may be only the garbage and other refuse, or it may be coal, wood or other fuel, depending upon the proportion and character of the refuse to be burned. The classes of refuse disposed of in incinerators and the amount of fuel required were as follows in 1915 for the cities named:

	Av. amount burned per day.				Amount fuel used per year.	
City.	Garbage, tons.	Ashes, tons.	Rubbish, tons.	Other mat'l.	Amt.	Cost.
San Francisco, Cal.—Garbage, rubbish, ashes, manure	229	49	188	...[1]	...	......
Cairo, Ill.—Garbage	21	...	...	...	360*	$720
Fort Wayne, Ind.—Garbage, small animals	33.47	..	. .	...	1,027*	2,824
Paterson, N. J.—Ashes, garbage, rubbish	23	...	...	...	.....[2]	108
Trenton, N. J.—Anything combustible	50	...	...	...	250*	750
Wilmington, N. C.—Garbage, rubbish, dead animals	3	...	37	...	...[3]	.....
Portland, Ore.—Garbage, manure, rubbish	123	...	19	...[4]	...[5]	......
Erie, Pa.—Garbage rubbish	21[6]	...	...	...[7]	724*	1,865
Richmond, Va.—Garbage, combustible matter (2 plants):						
	35	...	5	...[8]	290*	1,006
	35	...	5	...[9]	594*	2,050
Spokane, Wash.—Garbage, rubbish, manure	9.71	...	1.13	...[10]	144[17]	720
Wheeling, W. Va.—Garbage	20	.	...	...	...[11]	1,200
London, Ont.—Garbage, ashes	20.50	.[12]	...	...	...[13]	......
Montreal, Que.	116	. .[14]	..	...	...	......
Moose Jaw, Sask.—Garbage, manure	19.2	.	..	...[15]	...[16]	......

*Tons. [1]Manure 31 tons. [2]18 cd. wd. [3]6 tons and 44 cords. [4]Manure 11 tons. [5]None. [6]Includes rubbish. [7]Small animals. [8]Small animals. [9]Small animals. [10]Manure and small animals 0.72 tons. [11]25 million cu. ft. gas. [12]Ashes dumped in winter, burned rest of year. [13]None. [14]Includes all refuse. [15]Manure, etc., 22.5 tons. [16]None. [17]Cds.

Thus, 9 out of the 14 cities listed use other fuel in addition to the garbage and other refuse.

Cost of Construction.—The cost of construction varies, according to one report from $600 to $1,000 per ton capacity. The Worcester Commission reports that "the cost per ton daily capacity varies from $230 to $1,000, the average being between $600 and $700." The cost in a number of cities was as follows:

City.	Designer or builder.	Capacity, tons.	Construction cost.	Construction cost per ton capacity.
Berkeley, Cal.	Sterling	50	$61,500	$1,230
Oakland, Cal.	Decarie	100	60,000	600
Fort Wayne, Ind.	Dixon	40	15,000	375
South Bend, Ind	Dixon	25	6,800	272
Terre Haute, Ind.		50-75	15,000	200
Covington, Ky.		100	25,000	250
Grand Rapids, Mich	Angle Imp. No. 3	100	14,656	147
Duluth, Minn.	Decarie	25	35,000	1,400
Minneapolis, Minn.		150	50,000	333
Paterson, N. J.	Destructor Co.	60	80,000	1,333
Wilmington, N. C.	Decarie	40	35,000	875
Portland, Ore.	Smith	150	99,900	660
Allentown, Pa.	Dixon	25-30	14,700	490
Erie, Pa.	Morse-Boulger	100	27,000	270
Richmond, Va., No. 1	Decarie	50	40,000	800
Richmond, Va., No. 2	Morse-Boulger	50	12,000	240
Spokane, Wash.	Decarie	120	90,000	750
Wheeling, W. Va.	Decarie	50	35,000	700
Milwaukee, Wis.		300	210,000	700
London, Ont.	Heenan & Froude	50	39,750	795
Montreal, Que.	Thackeray	150	41,000	273
Moose Jaw, Sask.	Heenan & Froude	50	31,811	636
Average for 22 plants				$600

Cost of Operation.—The reports of charges for operation and maintenance were given for the following cities:

City.	Total.	Salaries.	Repairs.	Renewals.	Supplies, except fuel.	Fuel.
Ft. Wayne, Ind.	$7,150	$3,680	$ 157	$183	$ 325	$2,824
Paterson, N. J.	9,527	7,060	1,849	....	510	* 108
Portland, Ore.	15,383	13,805	1,330	....	248	......
Erie, Pa.	5,835	3,880	40	200	50	1,665
Richmond, Va., No. 1	3,706	2,250	350	....	100	1,000
Richmond, Va., No. 2	5,050	3,000	......	.....	......	2,050
Spokane, Wash.	3,930	3,165	45	....	......	720
Wheeling, W. Va.	5,690	3,540	800	. ..	150	1,200
London, Ont.	10,596	9,096	600	. ..	900	......
Montreal, Que.	23,445	......	......	....	......	......
Moose Jaw, Sask.	14,106	11,951	.... .	. .	2,174	......
Milwaukee, Wis.	68,892	....	......	....	......	......
Minneapolis, Minn.	43,000*	......	......	....	......	.....

*Approximately.

The Ohio State Board of Health reported the following costs including interest, depreciation, maintenance and repair charges, for the cities named for a period of years:

	Per ton.
Canton	$1.97 to $2.50
Marion	2.00 to 2.66
Steubenville	1.00 to 1.84
Zanesville	2.58

J. W. Turrentine, of the U. S. Department of Agriculture, reports the average net cost of incineration per ton for a number of cities as $2.11.

Venable gives the operation expenses as about 50 ct. per ton of kitchen garbage destroyed and nothing to $1.00 per ton for maintenance.

From the facts available it appears that the lowest probable cost of disposal of garbage by incineration is $1.59 per ton.

Revenue from Incinerator.—The products of the disposal of garbage in destructors are steam and clinker. The following are the earnings of incinerating plants reported from Milwaukee and Minneapolis:

City.	Amount.	Use.
Milwaukee	$10,000	Operates pumping station.
Minneapolis	27,000	Heats buildings, lights buildings and streets.

As to the utilization of the heat from incinerators for the development of power, the Chicago Waste Commission states that it has not been easy to work out an economical arrangement for the use of steam from incinerating plants because of the infrequency with which the period of need of steam by a plant will coincide with the period of operation of the incinerator. It is difficult to have the incinerator produce steam power during the hours that it is needed by the plant that is to use it, and vice versa. The installation should be so arranged that this source of power may be used to supplement other sources of power. This is done in Montreal, where the refuse destructor is used in connection with a municipal electric light plant. The destructor is operated only at night when additional power is required by the light plant because of the lighting load then in demand.

Minneapolis uses the steam generated to light and heat its hospital and workhouse buildings, and to light 31 miles of streets.

Savannah is reported as saving 96 per cent of the coal fuel formerly used at the pumping station, now providing the power from the destructor and using the clinker in road building.

Sanitary Aspects.—Incineration of garbage is sanitary and where properly conducted, permits of the disposal of garbage without odors. Thus, of the 13 cities disposing of their garbage by incineration, 12 reported no odors and one made no report. This freedom from odor and other insanitary features makes it possible to locate incinerating plants in the central part of a city and decrease the length and cost of haul. Since different kinds of refuse can be disposed of at the same time, they can all be collected at the same time and thus save the added expense of separate collections.

Reduction.

Sanitary Aspects.—In theory reduction plants should be operated in a sanitary manner, without creating a nuisance and without carrying offensive odors. In practice they are not so operated.

In the New York State report the following replies were obtained from cities disposing of garbage by reduction to the question as to whether odors came from their plants:

No	New Bedford.
Yes	Schenectady-Pittsburgh.
Slight	Columbus-Dayton.
Occasionally	St. Louis-Bridgeport.
Very little	Utica-Cleveland.
At times	Syracuse.
Much	San Francisco.
Some	Springfield.
40 miles away	Washington.
No reply	New York, Rochester, Cincinnati, Detroit, Baltimore, Boston, Newark, Indianapolis.

Thus, of the 21 cities, 8 did not report as to odors, 10 reported the presence of odors to a greater or less degree, 1 did not state whether there were odors or not but did state that the disposal plant was 40 miles away from the city, and 1 city reported no odors though officials from the city of Springfield visited the plant of this city and noted the odors coming from it. Four of the cities named above operate their own plants and all of them report odors. Thus, the fact of private or public ownership and operation does not appear to affect the nuisance.

That it is the expectation that reduction plants will cause offense and complaints is evident from the location of the plants with respect to the city, as follows:

Name of city.	Distance of plant from center of city.
Berkeley, Cal.	3 miles
Washington, D. C.	40 miles
Cleveland, Ohio	8 miles
Columbus, Ohio	4½ miles
Dayton, Ohio	About 6 miles

Cost of Construction.—The cost of construction of reduction plants in cities for which the information is available was as follows:

City.	Capacity, tons in 24 hours.	Cost of construction and extensions.	Cost per ton.
Los Angeles, Cal.	300	$100,000	$ 333
Chicago, Ill.	800	725,000	906
St. Louis, Mo.	400	300,000	750
Cleveland, Ohio	20-25	110,000	4,400
Schenectady, N. Y.	200	272,000	1,360
Columbus, Ohio	160	236,000	1,475
Dayton, Ohio	50	55,000	1,100

According to the New York State report the cost of construction varies from $1,500 to $3,000 per daily ton capacity.

The average cost of construction per daily ton capacity is $287 for these cities, excepting Schenectady, where the cost was reported to be $4,400.

Cost of Operation.—One authority, Parsons, places the cost of reduction at $1.80 to $2.00 per ton of garbage; Turrentine at $2.41; the New York State report at $1.50 to $2.50. In Columbus, Ohio, the cost per ton of garbage was as follows for the years indicated:

Year.	Cost.	Year.	Cost.
1911	$1.852	1914	$1.859
1912	2.050	1915	1.940
1913	1.910	1916	2.215

In Dayton, the cost per ton was $1.89 in 1916. Under normal conditions it would appear that the minimum cost of reduction per ton of garbage should be placed at $2.00.

Revenue from Reduction.—Adequate data concerning receipts and expenditures of reduction plants are available for three cities only:

City.	Expenditures.	Receipts.	Profit.
Columbus	$ 48,423	$ 88,564	$40,141
Cleveland	153,084	224,725	71,641
Dayton	30,938	41,200	10,262

The city of Cleveland reports a profit of $1.49½ per ton of garbage. The profit for Columbus in 1916 was $1.836 per ton, while that from Dayton's new plant is $0.63. The annual profit per ton of garbage in Columbus for each of the last six years was:

Year.	Profit per ton.	Total profit.
1911	$1.50	$26,239
1912	1.24	23,224
1913	.83	17,239
1914	1.225	26,501
1915	.477	10,910
1916	1.836	40,140

Those in charge of the Columbus plant have estimated their annual interest and depreciation charge at 6.92 per cent or $21,271. To get a true idea of the relation between revenue and cost of reduction, these items should be taken into account.

Year.	Profit.	Interest and depreciation charges	Net profit.	Loss.
1911	$ 26,239	$ 21,271	$ 4,967	......
1912	23,224	21,271	1,963	....
1913	17,239	21,271	.....	$ 4,032
1914	26,501	21,271	5,229	....
1915	10,910	21,271	.....	10,361
1916	40,140	21,271	18,069	....
Total	$144,236	$127,631	$16,625	......

It is assumed that the depreciation charges were the same for each year since data are not available showing when additions may have been made. The charge of $21,271 was as of 1914 and so does not include additions made since then. So that the inclusion of depreciation and interest charges for items not purchased in the early years should very nearly be counterbalanced by the omission of items purchased after 1914. The net profit for the six years is $16,625, an average of $2,771 per year.

The revenue of Cleveland per ton of garbage was given as $4.695, that of Columbus as $4.051 and that of Dayton, $2.522. Without doubt the amounts for Cleveland and Columbus are large because of the prevailing high prices. The revenue from Dayton is small probably because the plant has recently begun operations. It will be long, however, before prices drop to their former amounts.

Reduction in Columbus, Ohio.—Because the Columbus plant has been so successful, the following data have been taken from the annual report of the disposal plant:

ACTUAL COST OF OPERATION.

	For the year		Per ton garbage	
	1915.	1916.	1915.	1916.
Supervision	$5,201	$3,000	$0.227	$0.137
Clerk hire	.....	656	......	.030
Foremen	.....	2,349	......	.107
Foremen included in supervision of 1915.				
Firemen	2,638	2,970	.115	.136
Operators	4,592	4,248	.200	.194
Ordinary labor	11,223	13,123	.490	.600
Office supplies	.....	122	....	.007
Fuel	7,021	9,145	.306	.418
Clothing	.....	60	....	.003
Mechanical supplies	1,212	795	.053	.036
Motor vehicle	.....	256	....	.012
Chemical supplies	2,485	3,063	.108	.140
Other supplies	.....	493	....	.023
Traveling expense	.....	3	....	.000
Telephone and telegraph	.....	71	....	.003
Advertising	.....	16	....	.001
Insurance	.....	197	....	.009
Taxes and rent	.....	55	....	.003
Light and power	1,364	1,686	.060	.077
Other service	298	312	.013	.014
Maintenance buildings	.....	3	....	.000
Maintenance railway tracks	......	10	....	.001
Maintenance equip., labor	2,455	2,059	.107	.094
Maintenance equip., material	4,589	3,555	.201	.163
Maintenance motor vehicle	.....	161	....	.007
Other maintenance	.....	4	....	.000
Office expenses	316	.....	.014	....
Transportation	501	.....	.022	....
Miscellaneous	550	.....	.024	....
Total	$44,453	$48,423	$1.940	$2.215

ACTUAL PRODUCTION.

(Receipts corrected from inventories.)

	For the year		Per ton garbage	
	1915.	1916.	1915.	1916.
Grease (lbs.)	1,014.572	1,344.789	44.28	61.52
Tankage (lbs.)	4,596.140	4,506.610	200.62	206.14
Hides (No.)	220	156	......	......
Grease (value)	$38,048.57	$69,451.53	$1.661	$3.177
Tankage (value)	16,081.86	17,672.12	.702	.808
Hides (value)	1,233.56	1,440.42	.054	.066
	$55,363.99	$88,564.07	$2.417	$4.051

Items.	Cost.	Est. life, yrs.	Annual per cent deprec.	Value, 1914.
Buildings--				
Reduction building, green garden building, gasoline storage, office and one-half of stable	$71,177	50	2	$64,771
Percolator building	10,218	50	2	9,605
Brick chimney	4,600	30	3⅓	3,910
Digestors, roller presses, grease separating and storage tanks, hot well, screw press, liquor storage tank	36,615	15	6⅔	25,631
Receiving hoppers, jet condensers	1,000	10	10	550
Dryers and equipment	12,650	15	6⅔	8,855
Evaporators	9,400	8	12½	4,112
Boilers and stokers	7,615	12	8⅓	4,759
Conveyors and elevators	12,556	15	6⅔	8,789
Percolator, vaporizing tanks, condenser	6,030	12	8⅓	4,522
Gasoline storage tanks	1,045	20	5	888
Reinforced concrete condenser tank	946	20	5	927
Motors and switchboard	2,903	30	3⅓	2,467
Boiler feed pumps	574	20	5	444
Steel boiler flue	373	12	8⅓	233
Open feed water heater	944	12	8⅓	500
Water supply pump	1,317	..*	..*	300
Air displacement pumping equipment	4,046	..*	..*	1,000
Pipe lines	5,852	20	5	4,535
Oil storage tanks	172	15	6⅔	120
Railroad track scales	987	20	5	764
Railroad track trestles	5,182	20	5	4,024
Miscellaneous new equipment purchased from operating fund:				
In 1911	4,516	15	6⅔	3,462
1912	1,426	15	6⅔	1,189
1913	734	15	6⅔	660
1914	1,416	15	6⅔	1,368
Total and averages	$204,309	19½	....	$158,484
Engineering and miscellaneous	32,571	....	4.98	25,265
	$236,880	....	....	$183,749

*Not used any more. Value based on what could be secured for them if sold as second-hand machinery.

Annual charge for depreciation at 4.98 per cent	$11,796
Annual charges for interest on bonds at 4 per cent	9,475
Total fixed charges at 8.98 per cent	$21,271

Municipal vs. Private Operation of Reduction Plants.—The majority of reduction plants are owned and operated privately and dispose of garbage under contract with the city. The arrangement in 22 cities was as follows in 1916:

Private		Municipal
New York	Rochester	Schenectady
Syracuse	Utica	Columbus
Cincinnati	Detroit	Cleveland
Washington	St. Louis	Dayton
Baltimore	Bridgeport	Chicago
Pittsburgh	Boston	
New Bedford	Newark	
San Francisco	Los Angeles	
Indianapolis		

Only two cities that dispose of their garbage under contract with a concern employing the reduction method report any revenue in return for the privilege. These cities are Los Angeles and New York. The reduction company in Los Angeles pays the city $0.51 per ton. New York receives $112,500 a year. It is to be noted that Los Angeles also reports that it received $1.00 per ton from farmers for garbage delivered for feeding to hogs.

Feeding to Swine.

Cities Using This Method.—According to the New York report, 34 out of 112 cities were employing this method in 1915. According to the Municipal Journal the following cities of from 100,000 to 300,000 population employ the methods named:

Feeding to pigs....Albany, Cambridge, Denver, Grand Rapids, Hartford, Providence.
Reduction ....Bridgeport, Columbus, Dayton, Indianapolis, Rochester.
Incineration ......Portland, Ore.; Reading, Trenton, Paterson.
Dumping at sea...Oakland, Cal.

Turning Garbage Over to Private Pig Farms.—A city may turn its garbage over to farmers—for nothing or for a remuneration—to feed to pigs, or it may operate its own pig farm. The majority of cities feeding their garbage to pigs do so under the former arrangement. A few cities, including Worcester, Taunton, Brockton and New Haven, operate their own hog farms.

Revenue from Turning Garbage Over to Private Farms.—Many cities not only dispose of their garbage at no cost by the use of this method but also make it the source of a large amount of revenue. The following receipts are reported for the cities named:

Grand Rapids, Mich.	45 ct. per ton	$4,450
Denver, Colo.	Gets its collection and disposal for nothing.	
Cambridge, Mass.	70 ct. per cd. ft.	17,382
Colorado Springs, Colo.	Gets its collection and disposal for nothing, and	1,440
Salem, Mass.		*2,651
Somerville, Mass.	50 ct. per cd. ft.	
Lawrence, Mass.	$1.25 per load	†8,865
Lowell, Mass.	$1.25 per load	5,405
St. Paul, Minn.	80 ct. per ton	
Los Angeles, Cal.	$1 per ton	
Springfield, Mass.	Average per year, 1907-1911	4,262

*$13,255 in 3 yrs. †Estimated.

Many cities receive no revenue from garbage so disposed of. Thus, the revenue from this method of disposal varies from nothing in many cities to $17,400 in Cambridge. However, Denver, with a population of 265,000, has its 21,600 tons of garbage collected as well as disposed of by a hog growers' association; and Colorado Springs has its garbage collected and disposed of by hog growers and receives in addition $1,440. Assuming that the cost of collection in these cities was $0.30 per capita, which was two-thirds the per capita cost of collection reported in 1915 by 59 cities, the city of Denver saved $64,500 in 1916 and Colorado Springs saved $9,600 plus the $1,440 actually received.

Feeding Garbage on Municipal Hog Farms.—Worcester, Brockton and New Haven are among the cities that operate farms where they feed city garbage to pigs.

New Haven reports that during 1916 the department of streets fed to pigs the garbage collected from 52,100 of the population. $16,000 was received from the sale of pork.

Brockton paid $29,952 for the collection of its garbage and the operation of its pig farm. It received $15,761 from the sale of swine and of garbage. Thus, it both collected and disposed of its garbage at a cost to the city of $7,191.

From Dec. 1, 1916, to May 31, 1917, the city of Worcester has disposed of its garbage at an approximate cost of $7,500 and has received over $21,000. These figures were given by the superintendent in charge of the hog farm. He also estimated that during the year beginning Dec. 1, 1916, the city will spend $15,000 on account of the pig farm and receive $50,000 from the sale of products, thus making a profit of $35,000 on the disposal of garbage.

Initial Investment.—The probable cost of establishing today a piggery similar to that at Worcester was given as follows by Dr. Frederick Bonnett, Jr., of the Worcester Polytechnic Institute:

Stock	$ 49,700
Buildings	60,000
	$109,700

This means that an investment of $5,485 per daily ton would be required to establish the plant capable of disposing of a daily production of 20 tons. This does not include the cost of land which should run from $5,000 to $10,000.

S. A. Greeley, a sanitary engineer, of Chicago, Ill., submitted in 1916 the following estimate of cost of establishing a hog farm to handle an average daily production of 50 tons:

Pigs	$ 25,000
Buildings and other structures	110,000
Engineering and contingencies	25,000
Land	30,000
	$190,000

Cost of Operation.—The cost of operation per year was estimated as follows for Worcester:

Labor	$ 5,760
Grain and bedding	2,640
Medicine and disinfectants	5,040
Miscellaneous	1,000
Administration	2,500
Total	$15,000

At this rate to dispose of an average of 20 tons per day or 7,300 tons per year, the cost per ton of garbage would be $2.65. The cost reported by Greeley was at the rate of $1.98 per ton.

Revenue from Feeding.—The revenue from the Worcester Pig Farm is estimated at $50,000 for 1916. This is at the rate of $6.85 per ton of garbage.

Greeley estimated the yearly revenue from a 60-ton per day plant at $80,000. This would make the revenue per year per ton of garbage $3.65.

The revenue at Worcester is estimated on the basis of present prices; that by Greeley on prices last year. A fair estimate should be $3.75 per ton.

Electrically Operated Pumping Plant of Joliet

The city of Joliet, Ill., draws its water supply from wells sunk at seven different places. Pumping plants at each well feed a central plant which maintains the pressure in the mains and provides higher pressure in case of fire.

At the Ruby St. station a frame building houses equipment whose capacity is 1,500,000 gal. per day. An Ingersoll-Rand compressor, 17 in. by 10 in. by 16 in. belted to a Westinghouse 100 h. p., 690 r.p.m. wound-rotor induction motor, furnishes air to lift the water to the surface, after which it is forced into the pipe lines by a Goulds triplex plunger-pump belted to a 175 h. p., Westinghouse motor of the same type. Power is furnished at 2,400 volts, 3 phase, 60 cycles.

Ruby Street Pumping Plant. Foreground: Triplex Pump. Background: Air Compressor. Insert: Control Apparatus in Joliet Plant. Oil Circuit Breakers With Overload Trip, and Watthour Meter Mounted on Panels Below: Controllers for Motors.

This plant has been in operation for about seven months. Its only shut-downs have been for one hour daily for oiling.

A Page from Recent Waterworks Reports.

Cost of Plumbing Inspection at Chicago.—The Plumbing Inspection Section of the Water Pipe Extension Division of the Department of Public Works of Chicago, has charge of the inspection of all service pipe installation, investigation of complaints, inspection of service pipes on streets about to be paved and other special investigations as required. The following table shows the number of inspections made in 1916 and the cost:

Character of Inspections.	Number of inspections.	Cost.	Av. Cost.
New service pipes (scattered)	5,089	$7,176	$1.41
New service pipes (private contract)	8,888	5,272	.59
Retapping	3,028	3,887	1.28
Large service applications	249	1,677	6.72
Large service installations	240	1,521	6.33
Defective and abandoned pipes	1,031	3,217	3.12
Meters	7,088	12,499	1.76
Recording gauges	...	967	...
Drinking fountains	546	1,677	3.07
Inspections, account paving	...	4,454	..
Flushing mains	...	1,248	...
Supervising plumbing work	...	4,758	...
Complaints	7,128	9,594	1.34
Inspection account sidewalk construction	1,328	1,747	1.31
Inspection of cross connections	632	2,614	4.13
Inspection of fire reports and shutoffs	...	897	...
Loaned to Sanitary Department	...	780	...
Total		$63,987	

Eleven Years' Operating Results of Filter Plant.—The filtration plant of Harrisburg, Pa., has been in continuous operation since its completion in October, 1905. The following table shows the average turbidity, coagulants, length of runs and percentage of wash water during this period:

Year.	Turbidity parts per million.	Sulphate of alumina grs. per gal.	Calcium hypo-chlorite grs. per gal.	Length of runs. Hrs. Min.	Wash water Pct.
1906	101.	.95	...	18-20	2.0
1907	76.	1.05	...	12-20	2.6
1903	52.	1.09	...	13-29	2.6
1909	42.	.84	.025	14-22	2.4
1910	19.	.61	.063	18-40	2.2
1911	32.	.95	.070	23-07	2.3
1912	59.	.77	.067	21-54	2.3
1913	56.	.79	.069	17-26	2.9
1914	33.	.53	.056	20-17	2.9
1915	85.	.69	.064	17-41	3.2
1916	60.	.66	.045	16-39	2.6
Average	56.	.81	.057	16-11	2.6

The method of operating was as follows: The water is pumped to the settling basin, capacity 4,000,000 gal., flows by gravity to the secondary or coagulation basins, capacity 334,000 gal. and then flows by gravity to the 12 filters which are of the American gravity type. The filtered water is pumped to the storage reservoir, which has a capacity of 26,000,000 gal. and is uncovered, and is distributed by gravity. A small amount of this water is also pumped to supply the extreme high elevations. In the operation of the filter plant a coagulant, sulphate of alumina, is used. This is applied to the water as it enters the coagulation basin, and at time an additional amount is added to the water as it enters the settling basin.

Estimated Runoff from Snow Survey and Actual Runoff.—Each year the engineer of water supply of Salt Lake City, Utah, makes a snow survey of the Big Cottonwood watershed from which a part of the supply of the city is obtained. This work last year was begun on April 17 and continued for 6 days. In the upper part of the watershed where the snow ranged from 8 to 12 ft. it was very difficult to make density determination, as the tubes were only 74 in. long. This required that the snow be dug out with a shovel from 2 to 6 ft. in order to get the tube to the bottom. At these depths a very hard layer of snow was encountered from 4 to 6 ft. below the top which could hardly be penetrated with the tubes. The snow was found well packed and very much drifted. In all 90 density measurements and about 300 measurements for depth were made. The average snow depth was 56.7 in., and the average water equivalent was 24.69 in.; the average density was 41.8. The following table shows the actual total discharge in acre feet for the total watershed of 48.5 square miles as measured at city weir, compared with acre feet, as shown by snow survey, for months of May to September, inclusive.

	Acre Feet Measured at Weir.	Acre Feet Snow Survey.	Per Cent Actual Discharge.
1912	52,458	55,561	94
1913	36,098	31,705	114
1914	48,500	39,674	122
1915	29,380	24,663	119
1916	*40,729	42,682	95

*Includes 809 acre feet in storage Oct. 1, 1916.

Operating Costs of Slow-Sand Filtration Plant of District of Columbia.—Operating results of the purification plant of the District of Columbia for fiscal year ending June 30, 1916, were very satisfactory. The average bacterial count was reduced from 5,540 per cubic centimeter in the raw water to 15 per cubic centimeter in the filtered water and the turbidity from 238 in the raw water to 0 in the filtered water. The average daily consumption was 51.91 million gallons, making a per capita daily consumption of 145 gallons. The cost per 1,000,000 gal. for filter operations for the 10 years the plant has been in operation are shown in Table I.

TABLE I.—COST PER MILLION GALLONS FOR FILTER OPERATIONS.

LABOR.

	Office											
Fiscal year.	Filtration.	Main.	Laboratory.	Scraping.	Ejecting and washing.	Smoothing.	Re-sanding.	Raking.	Incidentals and repairs.	Filter attendants.	Pumping wash water.	Total.
1905-6	$0.06	$0.05	$0.20	$0.06	$0.31	$0.06	$0.04	.....	$0.02	$0.14	$0.01	$0.95
1906-7	.13	.02	.18	.07	.25	.02	.24	.....	.24	.11	.05	1.31
1907-8	.18	.04	.20	.09	.17	.01	.13	$0.02	.41	.11	.03	1.39
1908-9	.17	.06	.20	.07	.18	.01	.14	.01	.35	.12	.05	1.35
1909-10	.23	.07	.19	.05	.11	.02	.09	.01	.23	.12	.04	1.15
1910-11	.22	.03	.18	.06	.09	.01	.03	.02	.07	.12	.04	.87
1911-12	.19	.05	.18	.06	.08	.01	.03	.02	.07	.12	.03	.84
1912-13	.19	.08	.15	.06	.07	.01	.04	.03	.11	.13	.04	.91
1913-14	.20	.04	.19	.05	.07	.01	.03	.02	.20	.13	.03	.97
1914-15	.19	.04	.22	.03	.03	.00	.02	.02	.22	.14	.02	.90
1915-16	.20	.06	.19	.04	.04	.00	.03	.02	.07	.14	.02	.81

MATERIAL.

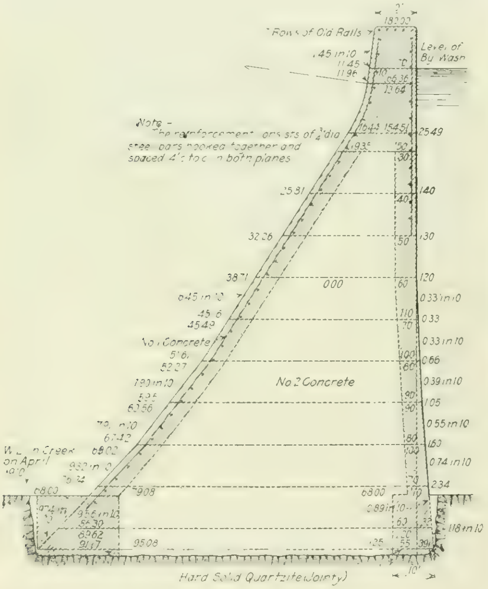
	Office											
Fiscal year.	Filtration.	Main.	Laboratory.	Scraping.	Ejecting and washing.	Smoothing.	Re-sanding.	Raking.	Incidentals and repairs.	Filter attendants.	Pumping wash water.	Total.
1905-6	$0.01	.....	$0.03	.....	$0.02	.....	.....	....	.....	.....	$0.01	$0.07
1906-7	.01	.....	.02	$0.01	.06	..	$0.01	.....	$0.20	.....	.04	.35
1907-8	.01	$0.01	.04	.....	.04	....	....	...	.07	.....	.02	.19
1908-9	.02	.02	.08	.01	.03	.....	.01	.....	.18	.....	.04	.39
1909-10	.02	.02	.11	.....	.02	.....	.....	.....	.05	.....	.03	.25
1910-11	.01	.01	.07	.01	.03	.....	.01	.....	.08	.....	.03	.25
1911-12	02	.....	.15	.....	.03	..	.....	$0.01	.03	.....	.03	.27
1912-13	.01	.01	.05	.01	.04	....	.03	.01	.11	.....	.03	.30
1913-14	.01	.....	.07	.....	.03	....	.02	.....	.10	....	.04	.27
1914-15	.03	.00	.06	.....	.02	.....	.01	.....	.01	.....	.02	.15
1915-16	.02	.....	.04	.....	.01	.....	.01	.....	.02	.....	.02	.12

Cabbage Tree Creek Reservoir of Brisbane, Australia

An $800,000 reservoir project has been completed recently by the Metropolitan Water Supply and Sewerage Board of Brisbane, Australia. The new reservoir dam is situated on Cabbage Tree Creek, a tributary of the Brisbane River, and lies to the northwest of the city of Ipswich, a distance of about 11½ miles and 30 miles from Brisbane as the crow flies, and 5½ miles from the pumping station. It is proposed to bring this water to the pumping station by a concrete conduit.

The dam is situated at the mouth of a gorge between two hills, beyond which the area opens out into a most suitable site for a large and commodious reservoir.

The rock at the site is what may be termed quartzite. The exposed strata shows decomposed quartzite, in some places to a considerable depth, overlying the blue quartzite which is tough, tenacious and impermeable and suitable for the foundation of such a dam.



Maximum Section of Cabbage Tree Creek Reservoir Dam.

The foundation of the dam is founded for the full width on the blue quartzite. This was found at 15 ft. below the creek bed and irregularly on each side of the creek. Although some 5,860 cu. yd. of extra excavation were removed to secure this foundation no unforeseen difficulties were met with in so doing, neither were any streams of water cut.

The dam is of cyclopean concrete, face work 1:2:4 concrete and the interior 1:2½:6½ concrete and includes 25 per cent of plums. The dam is of gravity section and 125 ft. high from foundation to top. It is 95 ft. thick at the base, the thickest part, and 10 ft. wide at the top.

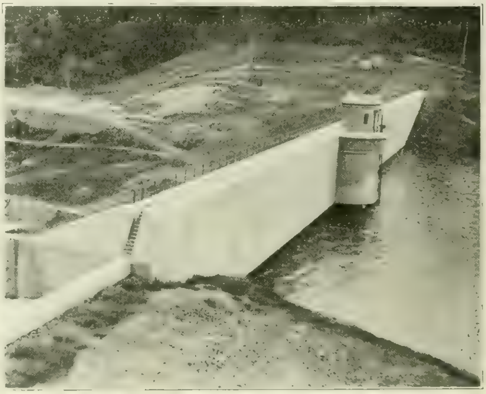
The length of the dam is 580 ft. and the length of the bywash 160 ft., a total of 740 ft.

The quantity of water that can be impounded by this dam is 5,800,000,000 gal. The surface area of the lake is 700 acres. The catchment area comprises 28 square miles of very suitable country for the purpose, hilly, well wooded and free from soft parts, hence the water comes off in a pure condition. The whole area of the reservoir was carefully cleared from timber and detritus.

The principal figures are:

	Cu. yd.
Excavation for dam	33,222
Extra excavation below assumed bottom	5,859
Excavation for bywash	64,500
Cyclopean concrete	58,400

The rainfall is intermittent, and for long periods there is none, but the area is subject to periodical heavy downfalls, when large floods have been recorded. The reservoir on May 1 was within 20 ft. of top water; it is, however, anticipated the next season's rains will fill the reservoir. The available quantity of water when full, after allowing for evaporation, may be taken at 12,000,000 gal. daily for 300 days, and, with economy, over a longer period. The largest period of drought known occurred in 1915 when the principal source of supply, viz., the Brisbane River, was dry for 8 weeks; the period of greatest scarcity of water may therefore be put at 100 days.



Cabbage Tree Creek Reservoir Dam.

The dam, and other works in connection with this reservoir, was carried out under contract by Mr. Arthur Midson. The actual cost of the reservoir and works under this contract was about $860,000. The works were supervised by John Peart, Engineer for Water Supply. The Water Supply as well as the Sewerage Works are under the control of the Metropolitan Water Supply and Sewerage Board of which Mr. E. J. T. Manchester, M. C. E., is the president.

The Board of Public Works of San Francisco, Cal., has rejected the bids received Aug. 22 for constructing about 19 miles of aqueduct tunnel, 10 ft. 3 in. in diameter, on the Hetch Hetchy Project. The low bid totaled $9,233,671, or an average of about $95 per foot, including accessory structures. It exceeded the city engineer's estimate by $2,926,000.

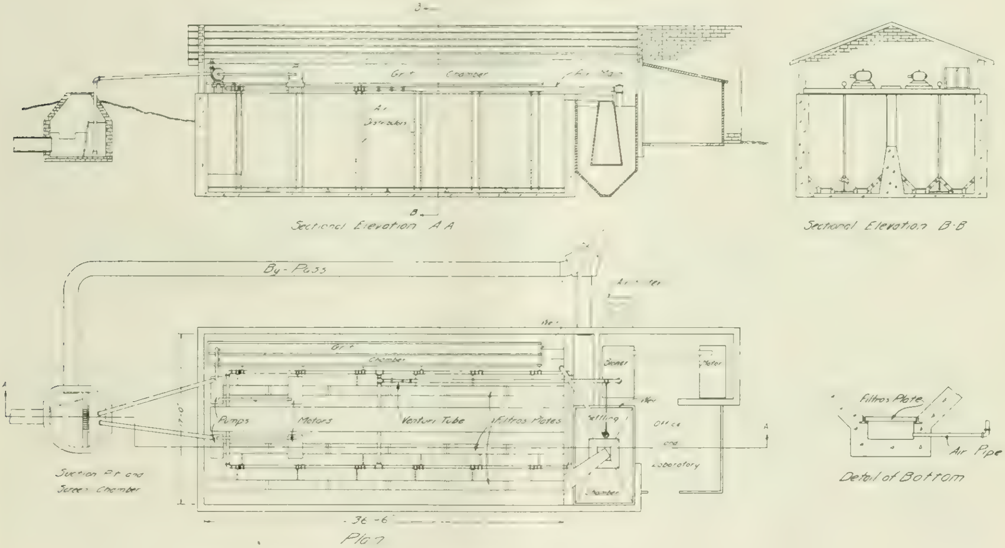
The total number of ships making the transit of the Panama Canal during the fiscal year ending June 30, 1917, in sea going traffic was 1,876. In 1916 the total was 787, and in 1915 it was 1,088. The aggregate gross tonnage in 1917 was 8,530,121.

Comparative Tests of Air Diffusers and Devices for Dewatering Activated Sludge

Results of comparative tests of methods of air diffusion in the activated sludge process and of devices for dewatering the sludge were outlined by Prof. Edward Bartow, Director of the Illinois State Water Survey in a paper presented June 20 at the Buffalo meeting of the American Institute of Chemical Engineers. The tests were made at the Sewage Treatment Station of the Survey at the University of Illinois during the first 6 months of this year. An abstract of Prof. Bartow's paper follows:

Method of Air Diffusion.

Four reinforced concrete tanks were remodeled and each fitted with a different air diffuser. The tanks operate on the fill-and-draw system and are 3 ft. 2 in. square and 8 ft. deep. At each filling 350 gal. of sewage were added.



Sectional Elevation and Plan of Experimental Station of Illinois State Water Survey.

One tank was fitted with a system of perforated pipes having perforations 1/25 in. in diameter placed 2 in. apart and staggered at an angle of 45° from the top of the pipes. There were about 40 holes in the pipes or 4 to each square foot of surface area. The bottom of the tank is sloped from the center and sides at an angle of 45°, thus forming two V-shaped channels of equal size, 1 ft. in depth, running entirely across the tank.

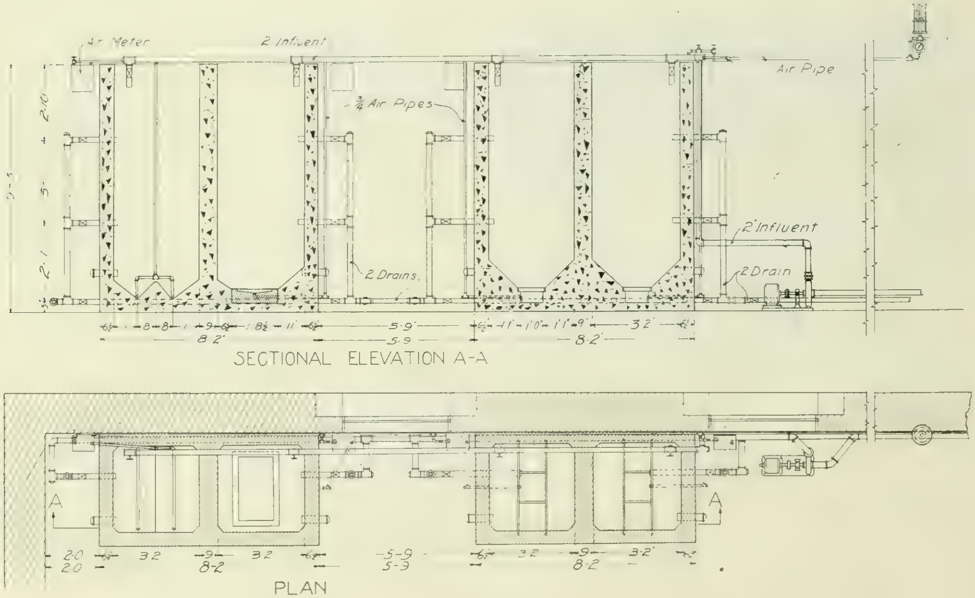
The bottom of the second tank was hoppered from all four sides and a concrete container for wooden-block air diffusers was placed in the bottom of the hopper. The container was patterned after one designed by Nordell and used at Milwaukee in the Nordell aerating tank. The container is a 1-piece casting 2 ft. 8 in. long, 1 ft. 8 9/16 in. broad, and 5 in. thick with a receptacle for the blocks 1 ft. 3 9/16 in. by 2 ft. 3 in. in plan, ¾ in. deep at the edge, and 1¼ in. deep at the center. The wooden blocks rest upon a series of 13 ridges, ½ in. wide and ¼ in. high that run across the receptacle leaving a ¼ in. space underneath for the air to circulate. The surface of the container was cast on a curve so that the tendency of the wooden blocks on swelling would be to wedge themselves more firmly into position. The basswood blocks used in the experiments were ½ in. thick, 6 in. long, and 2⅛ in. wide. At first, difficulty was experienced in keeping the blocks in position because of the excessive swelling that took place when they were placed under water and also because they became soft and spongy. Many of the blocks became so curved and twisted that they were discarded. It was found necessary to place strips of heavy galvanized iron on edge between each row of blocks for reinforcement and to close up certain joints with oakum.

Filtros plates of different porosity furnished by the General Filtration Co. were placed in two of the tanks. Three plates were used in each tank, covering one-third of the area and forming the bottom of a trough with sides sloping at an angle of 45°. The plates of the third tank were marked "fine" because on the basis of dry rating these plates passed 5.8 cu. ft. of air per minute per square foot under a water pressure of 2 in. When saturated with water and passing 2 cu. ft. of air per minute they showed a resistance on a water gauge of 11.4 to 11.8 in. The fourth tank was equipped with plates marked "coarse" which on the same basis passed 12 cu. ft. of air per minute per square foot. When passing 2 cu. ft. of air per minute these plates registered a resistance of 8.8 to 9.6 in. of water pressure.

The tanks were operated during three periods of 15, 20 and 35 days, respectively. Each of the tanks was operated in three aeration periods daily of 510, 300 and 270 minutes with a 2-hour allowance between the periods for settling, emptying and filling. The same amount of air as measured by ordinary gas meters was added to each tank. All conditions were maintained as nearly identical as possible. The sewage was pumped from the main sewer just outside the city limits of Champaign and accordingly was fresh. It was a fairly strong, domestic sewage with no trade wastes. No activated sludge was added to the tanks at the beginning of any of the series of tests.

Samples of sewage were taken as the sewage was being pumped into the tanks and samples of effluents were collected at the close of each aeration period after the sludge had been allowed to settle for 30 minutes. The methods of analysis were those given in the 1917 edition of Standard Methods for the Examination of Water and Sewage of the American Public Health Association.

In the first series of tests only the perforated pipes and Filtros plates were used. The series continued only 15 days. The average purification, measured in terms of removal of turbidity, removal of oxygen-consuming capacity, and the production of nitrate nitrogen was greatest in the tanks with the coarser Filtros plates, next in the tank with finer plates, and least in the tank with perforated pipes. Measured in terms of reduction of ammonia nitrogen and sludge accumulation the order was reversed. About 19,000 gal. were treated with 2.5 cu. ft. of free air per gallon.



Sectional Elevation and Plan of Sewage Experimental Plant, University of Illinois.

All four tanks were in operation in the second series of tests, which continued 20 days. Measured in terms of removal of turbidity, removal of oxygen-consuming capacity, production of nitrate nitrogen, and sludge accumulation, the tanks containing Filtros plates gave the best results. The tank with the wooden blocks was next and the tank with perforated pipes the poorest. Measured in terms of reduction of ammonia nitrogen, the tank with the perforated pipes was the best. About 17,000 gal. of sewage were treated with 1.8 cu. ft. of free air per gallon.

The third series of tests, which lasted 35 days, was the most satisfactory. (See Tables I and II.) There was no sludge present at the beginning and owing to the length of the test at times some of the excess of the accumulated sludge was wasted. No accurate comparison of the sludge accumulation at the end of the series can be made. The maximum amount of sludge was reached last in the tank with perforated pipes. Removal of turbidity and oxygen-consuming capacity was practically the same in all tanks. Measured in terms of removal of ammonia nitrogen and in production of nitrate nitrogen the tanks with Filtros plates were decidedly superior. Ammonia nitrogen was entirely removed in the tanks with Filtros plates after 17 days. Owing to rains nitrate nitrogen was present in the raw sewage during the early part of the series and continued to increase in the tanks containing Filtros plates reaching about 25 parts per million. Practically all of the nitrate nitrogen disappeared from the other tanks. The poor results from the tank with wooden blocks were probably caused by the development of a hole in the tank which prevented the formation of finely divided bubbles. The stability to methylene blue was tested on and after the eleventh day and all effluents from the tanks containing Filtros plates were stable for 10 days at 20° C. Most of the effluents from the other tanks were unstable. Nearly 30,000 gal. of sewage were treated in each tank with 3.2 cu. ft. of free air per gallon. The sludges in the tanks with Filtros plates settled better and after removal at the end of the series, had specific gravities of 1.013 and 1.022 compared with 1.006 for the sludges from the other tanks.

The results obtained from these comparative tests indicate the superiority of Filtros plates as air diffusers over perforated pipes, such as were used in our tests under the conditions maintained. The wooden blocks were difficult to handle though this was caused in part by the faulty design of our containers. Even in the time they were used there was evidence of considerable deterioration. From the results obtained little, if any, difference could be distinguished between the coarse and fine grades of Filtros plates. With air free from dust and oil there should be little trouble experienced from clogging of plates.

Dewatering of Activated Sludge.

Experiments in drying on sand beds were not successful. Owing to the large amount of moisture in the sludge, 98 to 99 per cent, the solid matter obtainable from a foot depth of sludge would be only from ¼ to ½ in. according to the residual moisture content. It was also difficult to separate the sludge and sand. The fertilizer obtained was more or less impure and of decreased value. The sand beds used were 0.01 acre in area and divided into five compartments. Underdrains were overlain with 10 in. of coarse gravel and 8 in. of sand. The beds were provided with a canvas cover supported on a frame work so that they could be protected during storms. One compartment was allowed to dry after a single filling, another after two fillings and another after three fillings. In no case were the results sufficiently satisfactory to warrant the use of sand beds for the drying of the sludge and the production of a commercial fertilizer.

TABLE I. SUMMARY OF RESULTS OBTAINED IN THE COMPARISON OF EFFICIENCY OF METHODS OF AERATION MEASURED IN TERMS OF AMMONIA NITROGEN, NITRATE AND NITRITE NITROGEN, AND OXYGEN CONSUMED.

(Parts per million.)

Period. 1917.	Ammonia Nitrogen Sewage.	Ammonia Nitrogen Effluents A	B	C	D	Nitrate and Nitrite Nitrogen Sewage.	Nitrate and Nitrite Nitrogen Effluents A	B	C	D	Oxygen Consumed Sewage.	Oxygen Consumed Effluents A	B	C	D
March 27-April 1	21	17	17	18	17	.9	1.2	4.0	3.9	3.9	58	26	19	20	22
April 1-6	17	17	16	16	16	4.7	3.9	4.7	6.1	6.3	46	21	18	15	14
April 6-12	16	11	9	8	9	5.1	4.9	4.5	5.9	7.2	50	26	24	19	26
April 12-17	26	30	29	0	0	.3	.4	.3	6.8	10.2	55	32	26	25	16
April 17-22	21	21	21	0	0	1.2	.3	.0	15.0	16.9	..	..	..	..	..
April 22-27	25	24	23	0	0	1.0	.2	.1	25.8	26.0	..	..	..	..	..
April 27-30	22	30	20	0	0	4.5	.3	.0	23.8	24.7	..	..	..	..	..
Average	21	20	19	6	6	2.5	1.7	1.9	12.6	13.6	52	21	22	20	19
Reduction		5%	10%	71%	71%							60%	58%	62%	63%
Results April 12-30 after Activated Sludge was formed.															
Average	24	24	23	0	0	1.7	.3	.1	17.8	19.4	55	32	26	25	16
Reduction		0%	4%	100%	100%							41%	53%	54%	70%

A—Tank with perforated pipes.
B—Tank with wooden blocks.
C—Tank with fine Filtros plates.
D—Tank with coarse Filtros plates.

Experiments with a filter press with leaves 8½ in. square operating on a fairly concentrated sludge were also unsatisfactory, it being impossible to obtain a cake of good consistency. Further experiments are to be tried with the hope that better results can be obtained.

TABLE II.—SUMMARY OF RESULTS OBTAINED IN THE COMPARISON OF EFFICIENCY OF METHODS OF AERATION MEASURED IN TERMS OF TURBIDITY AND THE ACCUMULATION OF SLUDGE.

(Parts per Million.)

Period, 1917.	Turbidity Sewage.	Turbidity Effluents A	B	C	D	Per Cent Sludge Effluents A	B	C	D
March 27-April 1	282	48	39	46	46	9	8	8	7
April 1-6	317	9	6	6	6	14	14	12	12
April 6-12	190	9	5	5	5	18	21	18	18
April 12-17	248	7	5	5	5	26	29	25	28
April 17-22	306	5	5	5	5	29	35	34	31
April 22-27	309	5	5	5	5	38	37	44	39
April 27-30	268	5	5	5	5	35	33	36	33
Average	274	13	10	11	11				
Reduction		95%	96%	96%	96%				
Results April 12 to 30 after Activated Sludge was formed.									
Average	283	5	5	5	5	38	37	44	39
Reduction		98%	98%	98%	98%				

Through the courtesy of the Koering Cyaniding Co. of Detroit, a rotary filter was obtained. This style of filter is used satisfactorily in filtering slimes in extracting gold and silver by the cyaniding process. The apparatus consists of a cylinder of Filtros plates supported on a perforated steel cylinder, outside of which at a distance of about 1 in. is a solid steel outer shell. The material to be filtered is forced into the interior of the cylinder of Filtros plates, the cylinder is revolved and a cake of sludge is built up on the inside of the plates. The liquid filters through the plates into the space between the cylinders. Air pressure can be exerted from the interior to dry the cake, and from the exterior to loosen it. The plates can be cleaned by back-flushing with water. The first trial with a comparatively heavy and not very fresh sludge did not give satisfactory results. The quick-opening door could not stand the pressure. Another trial will be given as soon as the door can be replaced.

Mohlman reported experiments with two small centrifuges, one of the low-speed basket type and the other of the high-speed bottle type. The basket of the low-speed machine was 8 in. in diameter and 6 in. deep. The periphery was perforated with numerous holes 1/16 in. in diameter. When the holes were covered with a strip of muslin cloth, approximately 1 gal. 98 per cent moisture sludge was put into the centrifuge and after 15 minutes, 700 grams of 91 per cent moisture sludge were obtained. The high-speed bottle-type machine reduced the moisture from 98 per cent to 92 per cent in three minutes. Mohlman stated that in order to be economical there should be an automatic arrangement for removing the cake.

At Cleveland, Pratt and Gascoigne used a laundry centrifuge with a 26-in. basket, lined with a ¼ in. wire mesh inside of which was a canvas bag. In the best run, when the basket revolved about 1.200 revolutions per minute, 60 gal. of 97½ per cent moisture sludge was added in about 25 minutes and in 2 hours the moisture content was reduced to 84 per cent. The time required would seem to make this process impracticable.

Working on the assumption that the principle used in drying of china clays or that used in the cream separator might be applicable, a modified basket-type centrifuge and a modified cream separator were tried. The holes of an 8-in. basket-type centrifuge were covered with a strip of rubber packing. The best results were obtained with 1,500 revolutions per minute, which was the limiting speed of the machine. This would seem to indicate that the process would give efficient results if carried on at an increased speed, but would yield an effluent that must be returned with the sewage to the aeration chamber. A series of tests was made with a cream separator, the bowl of which was modified, by removing the inner disks and discharging the clarified liquid about an inch from the center of the bowl at the top. The sludge added at the top dropped to the bottom of the bowl, and the liquid was thrown out over the rim. Sludge cakes containing from 85 to 86 per cent of moisture were obtained by the cream separator in 6 to 8 minutes, which encouraged us to obtain a special machine for further experiments.

A specially designed centrifuge was purchased from the Tolhurst Machine Works, of Troy, N. Y. This machine is 12 in. in diameter, 9½ in. high and at a speed of 1,800 exerts a centrifugal force of 550 lbs. According to its concentration from 10 to 25 gal. of the sludge are added and 10 lb. of cake obtained. The sludge cake contains about 88 per cent moisture. The space underneath the rim contains 0.158 cu. ft. Owing to the small size of the machine and to the fact that the material must be scraped out, the time of cleaning is longer than would be required for a larger machine with an opening in the bottom, so that a large machine could undoubtedly have been filled and emptied more rapidly than the small laboratory machine. It was found entirely possible to fill and empty the small machine four times in one hour. Calculating that the same rate could be used with a 40-in. machine having 46 times the capacity, it was possible to obtain in each filling 460 lb. of sludge of 88 per cent moisture, equivalent to 55 lb. of dry material. One 40-in. machine would, therefore, deliver the equivalent of 2,200 lb. of dry material in a working day of 10 hours. On the supposition that ½ ton of dry material will be obtained from 1,000,000 gal. of sewage, one machine would dewater the sludge from 2,000,000 gal. of sewage per day. The cost of the 40-in. machine at present is only $750 and the power to run it is small enough to make the process appear practical for preparing sludge cake for a dryer.

The actual cost of dewatering will depend upon the amount of water that can be removed by the centrifuge, the size of dryer and the amount of coal required for removing the residual water. A drying test using 220 lb. of 88 per cent sludge cake made by the John P. Devine Co. indicates that the dewatering process can be made practical.

Laboratories for Chemical and Bacterial Tests at Small Water Works

The desirability of small filter plants having their own laboratories for chemical and bacterial tests was pointed out by Mr. Ray C. Werner, Chemist, Georgia State Board of Health in a paper read at the last annual meeting of the Tri-State Water and Light Association. An abstract of Mr. Werner's paper follows:

It is becoming more and more evident that bacterial analyses at such frequent intervals as several times a week or once daily are really needed to accurately check the quality of the water. This is particularly true of the plants deriving raw water from large streams, which vary considerably, sometimes quite suddenly, in bacterial contents, chemical quality and turbidity. Another valuable feature of the plant laboratory is that the control is direct, enabling the superintendent and attendants to interpret the results in relation to the procedures of plant operation; and, too, the results of bacterial tests may be promptly observed on the first or second day after taking samples. In shipping samples there is necessarily considable delay in obtaining the results and therefore the intimate touch with plant operation is lost. As one of the prime objects of the examination is to correct faults in operation of the plant, prompt bacterial results are needed. This point is of the greatest importance because, after all, the bacterial examination only shows what the filter has accomplished as regards purification and the plant must be efficiently operated in order to furnish a water of bacteriological purity.

For several years the State Board of Health of Georgia has encouraged the superintendents and local officials at waterworks to start small local laboratories. There are at present such laboratories at Atlanta, Columbus, Commerce, Milledgeville, Jackson and LaGrange. At Jefferson the matter is under consideration. The first plant laboratory in the state was the one at Milledgeville at the Baldwin County Water Co., owned and operated by the American Pipe & Construction Co. of Philadelphia. This laboratory has now been in service for at least 5 or 6 years and has furnished valuable data as to the quality of water provided for the city—something especially desirable and valuable where the public supply is owned by a private corporation.

Probably more laboratories would have been established were it not for the fact that the superintendents are apt to regard bacteriology as too difficult and too time-consuming to be undertaken lightly as an addition to their regular duties. Also those who have not investigated the subject frequently consider the expense of the laboratory as too great for the means of the waterworks department. It is often true, too, that local water and light commissions and similar political bodies having charge of finances in small cities discourage any extra expenditures of money no matter how important they may be. This is particularly apt to apply to such a matter as a bacteriological laboratory, dealing as it does with a subject not yet familiar to the general public. Those who undertake the step of starting a laboratory therefore must be prepared to meet some opposition and discouragement at the start.

As to the cost, it is now possible to secure good equipment for routine water bacterioloogy, such as the bacterial counts and tests for B. coli, at about $125. The cost of chemicals and bacteriological media is quite small after the laboratory is once started. The incubators, sterilizers and similar equipment can now be bought to operate by electricity, gas, or gasoline as may be most convenient. Electricity is now available at almost every waterworks, so that electrical equipment is desirable.

The average superintendent can easily learn the necessary bacteriological technique for making routine control tests. He should be provided first with one or two good books on water bacteriology and filter plant operation. After some familiarity with the subject has been gained by the study of such books, the superintendent can acquire actual experience in plating out samples, the sterilization of media and other procedures of routine bacteriological work. After a few days of this training under an experienced worker, he is in a position to start his own work, making the counts and the presumptive test for B. Coli daily or at frequent intervals. Of course, he will usually make some errors at first, as is perfectly natural, but within a few weeks he can by study and application have an accurate working knowledge of the principles of water bacteriology. As his experience and training broadens, the superintendent can take up the more complex procedures of bacteriology, including microscopical work and the study of fresh-water biology and related subjects. Such studies, however, are largely matters of personal ambition with the individual and while very desirable are not absolutely necessary in securing plant control and producing pure water.

Recent Progress and Tendencies in Water Filtration

An excellent summary of the recent progress in the field of municipal water supply engineering was given by Mr. John W. Alvord, Consulting Engineer, Chicago, in a paper presented at the last annual convention of the American Water Works Association. That portion of the paper relating to water filtration follows:

Stimulated by wide dissemination of modern ideas of sanitation, water filtration in the United States has made great progress during the past decade. The population supplied by filtered water, as shown by Table 1, has increased from 3,160,000 in 1904 to 17,291,000 in 1914. As late as 1903 only about 60 cities and towns were supplied with filtered water, while there are now some 480 filter plants in this country with a total capacity of 2,585,000,000 gal. per day. These filters serve 40.86 per cent of the urban population, while in 1904 only 9.68 per cent of the urban population (including all towns of over 2,500 population) was so supplied.

The relative growth of slow sand and rapid sand filtration during this period is interesting. It reflects strongly the relative adaptability to conditions in this country of the two types of filters and the gradual acceptance by the general public of ideas in water purification looked upon with prejudice less than ten years ago. Although slow sand filters were the first to be introduced, by 1904 rapid sand filters, including the earlier "mechanical" filters, were far in the lead with a total population served of 2,600,000, as against only 560,000 supplied by slow sand filters. From 1904 to 1908 several very large slow sand filter plants were completed, at Philadelphia, Pa., Washington, D. C., and at Pittsburgh, Pa., and the relative lead of rapid sand filters was much reduced, although even then the population served by rapid sand filters was very nearly twice that supplied by slow sand filters. Since 1910 the growth of slow sand filters has been less marked. In 1914, a population of 5,398,000 received water from about 30 slow sand filters, while upwards of 450 rapid sand filters supplied a total population of 11,893,000.

Although there are now in this country 15 rapid sand filter plants to one slow sand plant, the capacity of the larger slow sand filter plants is greater than that of any rapid sand filters yet built. The largest slow sand filter, located at Philadelphia, and in service since 1908, has a rated capacity of 240,000,000 gal. per day. In contrast to this, the rapid sand filter at Cincinnati, completed in 1907, with a capacity of but 112,000,000 gal. per day is the largest plant of this type in operation up to 1915. Present tendencies in this country are indicated by the fact that several cities are now building mechanical filter plants larger than any now in operation, while no large slow sand filter plants are under construction or projected. A rapid sand filter of 320,000,000 gal. capacity, 30 per cent larger than any existing slow sand plant, has been designed for the Croton water supply of New York. St. Louis has recently completed a rapid sand filter of 160,000,000 gal. capacity, at Cleveland two rapid sand filters are proposed, with a combined capacity of 225,000,000 gal., one of which is now about ready for service, the larger plant of the two having 150,000,000 gal. capacity, and Baltimore has a new rapid sand filter of 128,000,000 gal. capacity.

The rapid sand filter has outstripped the slow sand filter principally because it is better adapted to handling waters of the high turbidity characteristic at times of practically all our rivers outside of the extreme northeasterly portion of the United States. In many parts of the country, the slow sand filter, unaided by auxiliary processes, more especially coagulation and preliminary sedimentation, would be incapable of continuously handling the water except at greatly reduced rates of filtration, owing to the rapid clogging of the beds and great difficulty and time required in cleaning. The rapid sand filter, using coagulation and ample preliminary sedimentation that relieves the filters proper of a very large share of the burden of purification, and with easy means of cleaning the filter beds, has, on the other hand, repeatedly demonstrated its ability to properly and economically filter the most turbid waters. The growing recognition by engineers of the merits of the rapid sand filter is evidenced by the final recommendation in a number of instances of rapid sand filters, reversing earlier recommendation of slow sand filters, as in the case of New York City, Baltimore and Minneapolis.

Although the limitations of slow sand filtration in handling waters of high turbidity were early realized, these filters were often favored in preference to rapid sand filters. Popular objection to rapid sand filtration arose on account of its use of a coagulant. This prejudice is well illustrated in the case of Washington, D. C., where popular agitation resulted in the building in 1905 of a slow sand filter after the original recommendation of a rapid sand filter. Prejudice against the use of alum, and, in fact, against the use of other chemicals, either for coagulating, softening, or sterilizing water has now been for the most part overcome. This is mainly due to the extensive use of coagulation at a large number of rapid sand filter plants, occasionally in conjunction with water softening, without ill effects on the consumer, and to the well earned public favor enjoyed by the process of water sterilization by means of hypochlorite of calcium.

While the rapid sand filter has overcome the prejudice under which it labored 10 or 15 years ago, and has been demonstrated as equal, if not superior in bacterial efficiency to the best slow sand filters, it is of interest to note that the attempt in recent years to apply slow sand filtration outside of its proper zone of relatively clear natural waters has not met with success. This attempt has brought about very radical

TABLE I—GROWTH IN POPULATION SUPPLIED WITH FILTERED WATER IN THE UNITED STATES BY SLOW SAND AND BY RAPID SAND FILTERS.

	Total urban population in the U. S. (towns and cities above 2,500).	Pop. Supplied with Filtered Water			Pct. of Urban Pop. Supplied		
Year.		Slow sand filters.	Rapid sand filters	Total.	Slow sand filters.	Rapid sand filters.	Total.
1870	....	....	....	....	....	....	....
1880	13,300,000	30,000	....	30,000	.23	....	.23
1890	21,400,000	35,000	275,000	310,000	.16	1.29	1.45
1900	29,500,000	360,000	1,500,000	1,860,000	1.22	5.09	6.31
1904	32,700,000	560,000	2,600,000	3,160,000	1.71	7.95	9.66
1910	38,350,000	3,883,000	6,922,000	10,805,000	10.13	18.05	28.18
1914*	42,500,000	5,398,000	11,893,000	17,291,000	12.70	27.98	40.68

*Compiled January 1914, by George A. Johnson.

departures from early slow sand filtration practice, and has obscured the original sharp distinction between this type and the rapid sand filter, without evolving a superior filter. It has been necessary to resort to coagulation at the Washington slow sand plant, in spite of very long preliminary sedimentation. At Philadelphia and at Albany, preliminary filters, which are practically rapid sand filters, have been added to better enable the slow sand filters to do the work originally expected of them. At Pittsburgh extensive modifications have been necessary to properly prepare the water for the slow sand filters that had been proved incapable alone of producing a satisfactory effluent. The reliance now placed on sterilization of the filtered water at most of the principal slow sand filter plants shows further the wide departure made from the original slow sand process, in the effort to keep the performance of some of these plants up to the standard originally intended of them without the help of these and other auxiliary processes. All of these processes are foreign to the original idea of a "natural" process for water purification which gave to the slow sand filter much of its vogue and played an important part in meeting the early competition with the so-called "mechanical" filter and the present rapid sand filter.

The process of rapid sand filtration was highly standardized 10 years ago, and has undergone little change in the last few years beyond the incorporation of water sterilization as an additional safeguard, and a more general appreciation of the importance of preliminary sedimentation. Filters of this type follow closely the lines of the original modern rapid sand filter built in 1902 at Little Falls, N. J.

Although it is well understood that any filter has a definite limit of capacity beyond which it is not possible to obtain properly purified water, there is a tendency to operate filters at greater than the safe rates, as the plants are outgrown. The danger in this practice is evident, and engineers generally are disposed to discourage it, and, so far as possible, to anticipate it by designing with ample provision for the needs of the immediate future, and with special attention to facility for making future additions.

There is a further tendency of late to overconfidence in filtration as a preventative of disease, and a disposition in some quarters to attempt the filtration of badly polluted waters in preference to more expensive and distant sources. The engineer and the sanitation of today is engaged in pointing out that it is not a proper or wise policy to overload water filters from a poor source of supply.

The field of possible application of water filtration, and more particularly rapid sand filtration, is today a very broad one. Practically all river and large lake municipal water supplies, and many impounded supplies, must eventually be filtered to meet the rapidly spreading demand for uniformly safe and potable water. We may reasonably look forward to an extension of water filtration during the next decade fully as great as the growth from 1904 to 1914.

Of the 16 cantonments being constructed for the new national army, seven were ready on Sept. 5 to receive their entire quotas of officers and enlisted men. Seven other cantonments had been sufficiently completed on that date to receive all officers and two-thirds or more of their entire quota of enlisted men. The two remaining cantonments had already received their full quota of officers and were ready to receive the enlisted men ordered there on Sept. 5.

Unstable Condition of Flow in Flume with Water at Critical Stage

In connection with the experimental investigations made on the North Platte Project of the U. S. Reclamation Service during the irrigation season of 1916, several observations were made of flow conditions in one of the flumes. These observations were made primarily for the purpose of determining the inlet and outlet losses and the value of Kutter's "n" for the flume. Studies of the data submitted revealed, however, a very interesting and important condition of flow separate from the original objects of the investigation. The results of these studies are set forth in the August Reclamation Record, from which the matter following is taken.

The flume under consideration is a semicircular steel type, with smooth interior, known commercially as a Hess No. 204. The inside diameter is 10.823 ft. It is constructed on a tangent and has a total length between head walls of 240 ft. The field observations consisted of:

1. Profile of water surface.
2. Profile of subgrade.
3. Elevation of top of flume.
4. Measurement of discharge through the flume.

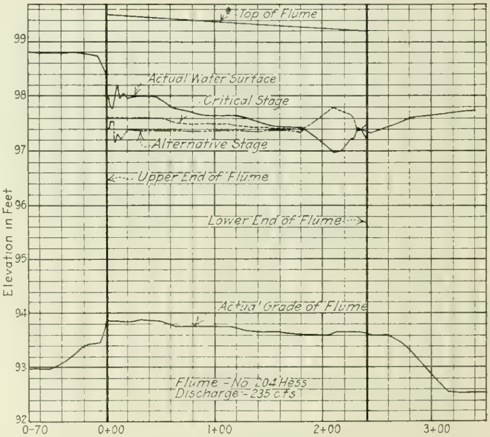


Fig. 1—Flow Conditions.

The observations made on July 20, 1916, were taken as representative of flow conditions, and Fig. 1 has been prepared on which are shown in full lines the profiles of actual subgrade, actual water surface, and the top of the flume. The discharge through the flume at the time of making the above observations was 235 cu. ft. per second.

An examination of the water-surface profile shows that the flow through the flume is decidedly unstable, especially so at the upper and lower ends of the flume. This general unstable condition of flow, together with the decided drop and jump in the water surface at the lower end, was identical in each test made and led to the belief that the flow must be at or near the critical depth. To substantiate the above theory studies have been made of the flow conditions throughout the flume and are described below.

With a discharge of 235 second-feet, various depths in the flume were assumed and the resulting area, velocity and velocity head for each depth computed. These data were plotted (see Fig. 2) with the depths in the flume (D) as abscissae and the energy required to maintain the flow at these depths as ordinates. The energy required is equal to $D + h_v$, where D represents static head and h_v velocity head. The resulting energy curve for a flow of 235 second-feet through the flume was then drawn in as shown.

From the shape of the curve it follows that there are two depths at which the flow will take place with the same energy. These two depths are known as the lower alternative stage (stage of high velocity) and the upper alternative stage (stage of low velocity). The curve also clearly demonstrates that there is one depth at which the two stages merge into one, this being the lowest point on the curve and hence the depth of flow requiring the least energy. This depth is known as the critical depth.

As the depth becomes less than the critical, the flow is taking place at the high velocity of the lower alternative stage, and if obstructed will jump and flow under the condition of the upper stage of low velocity. With the flow taking place at or near the critical depth, as shown by the flatness of the curve at this point, any slight change in energy will cause a decided change in the depth. It is thus to be expected that in such a case the water surface will be very rough and the depth will shift back and forth along the curve and a jump may be expected if the flow is at all restrained.

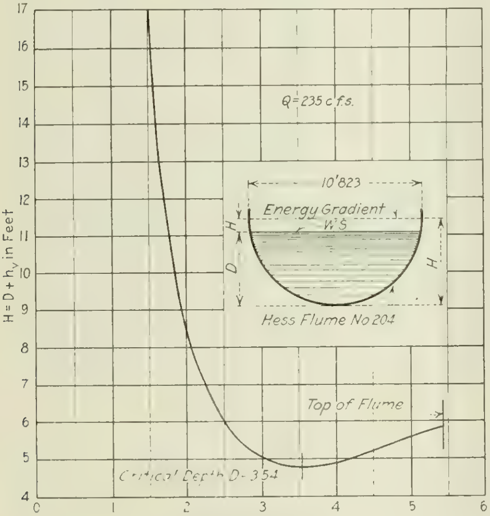


Fig. 2—Energy Curve.

The velocity at which the water will flow at the critical stage is termed the critical velocity and may be shown to be equal to $V = \sqrt{g\frac{A}{T}}$, the corresponding velocity head being $h_v = \frac{A}{2T}$, in which—

V = critical velocity.
g = acceleration due to gravity.
A = cross sectional area of flume.
T = width at water surface.

From this formula, the depth at which the critical velocity is developed may be obtained. For the case in hand this was found to occur at a depth D = 3.54 ft. with a velocity of 9.09 ft. per second. Thus we have the co-ordinates for the critical stage as follows: $D = 3.54$, $D + h_v = H = 4.82$. These were plotted and furnished the lowest point through which the energy curve must pass.

Having obtained the critical depth, D = 3.54 ft., the dotted line indicating this depth of flow throughout the flume was plotted on Fig. 1. This line is called the "critical stage." It is observed that the actual water surface for the test is very close to the critical stage throughout the flume and from the explanation given above it follows that the extremely unstable condition of flow is to be expected.

As stated above and as is shown by the "energy curve," there are two stages at which the flow will take place for any definite energy. In Fig. 1 the actual water surface is taken as one stage and for each observed elevation the opposite stage is picked off of the "energy curve" and plotted. These points are then connected and this line represents the alternative stage at which the water could have flowed in this particular flume with the same energy with which the flow actually took place.

It is observed that up to station 1+83 the flow takes place at the upper alternative stage, but that the actual was so close to the critical stage that the flow was very rough and unstable, and with a slight change of energy could easily have shifted to the high velocity or lower alternative stage. At station 1+83 the flow line drops below the critical stage and assumes the lower alternative stage. At station 2+30 the flow jumps to a point near the critical stage and then drops again to the lower stage. This rise at station 2+30 was probably caused by the raise in the subgrade. Had this raise in subgrade been a little more pronounced the flow line would have taken approximately the elevation 97.78 as shown for the alternative stage. However, it probably would not have fully attained this elevation due to eddies through which the energy is dissipated.

The above data show the unstable conditions of flow which may be expected to take place in a flume with the water flowing at or near the critical stage. The necessity for consideration of the above principles in connection with flume design is no doubt apparent, and it is believed that for all flume designs in which the water is flowing at a high velocity similar investigation should be made before final designs are prepared, and that in case of flow at or near the critical stage additional freeboard should be provided.

Cost of Preliminary Treatment for Filtered Water of Washington, D. C.—Preliminary treatment at the coagulant plant of the filtered water supply of the District of Columbia for the fiscal year ending June 30, 1916, cost 69 ct. per 1,000,000 gal. filtered, an increase of 9 ct. over the previous year. This increase as will be noted from the accompanying table was due to the higher prices for alum.

Fiscal year	1911-12.	1912-13.	1913-14.	1914-15.	1915-16.
Average daily consumption (1,000,000 gal.)	61.95	57.44	56.43	54.54	51.91
Number days used	110	79	84	107	109
Hydrated lime used, tons	.....	.....	.....	64.8	53.5
Alum used, tons	534.5	328.2	293.7	430.5	431.6
Cost per 1,000,000 gal. filtered:					
Labor	$0.05	$0.06	$0.07	$0.08	$0.09
Alum	.48	.33	.31	.47	.56
Lime	....	....	....	.02	.02
Supplies	....	.18	.01	.03	.02
Totals	$0.53	$0.57	$0.39	$0.60	$0.69

Effect of Creosoted Wood Stave Pipe Upon Water for Domestic and Irrigation Uses

Experiments to determine the effect of creosoting on the quality of water passing through wood stave pipe have been made recently by the Bureau of Industrial Research of the University of Washington. The tests to determine the effect upon the potability of water passing through the pipe were made with a 48-ft. section of 4-in. creosoted Douglas fir stave pipe. The treatment was 16 lb. of creosote per cubic foot of wood. In the experiment the water was circulated through the pipe for 6 hours at a velocity of 5 ft. per second before taking each sample. The taste of the water was accepted as evidence of its potability. It was found that after the experimental pipe line had been in service for 13 days, no taste of creosote could be detected in a sample of the water diluted with two parts of ordinary city water. After the experimental pipe line had been in service for 29 days, no taste of creosote could be detected in undiluted water flowing through it.

The test was extended to determine the effect of minute quantities of creosote upon the availability of the water in irrigation. The conclusion reached as the result of the test was:

The amount of creosote that diffuses into water in ordinary creosoted pipes does not have an appreciable injurious effect upon plants either in the time of germination, the percentage of germination, the rapidity of growth or the general vigor of the plant.

Cost of Cleaning Catch Basins at Cambridge, Mass.

Cost data on cleaning catch basins by the Sewer Department of Cambridge, Mass., are given in the last annual report of L. M. Hastings, City Engineer. The figures cover the period 1905-1916 inclusive and are as follows:

		Quantity			Cost		
Date.	No. of C. B. cleaned.	Total loads.	Loads per C. B.	Total cu. yd.	Total.	Per C. B.	Per cu. yd.
1905........	2,169	5,213	2.40	3,909	$6,089	2.80	1.55
1906........	2,340	5,609	2.82	4,206	6,050	2.58	1.44
1907........	1,948	4,704	2.40	3,528	5,070	2.60	1.44
1908-9*.....	2,742	5,906	2.15	4,429	8,090	2.95	1.82
1909-10.....	1,874	4,157	2.22	3,118	6,732	3.32	2.16
1910-11.....	1,672	4,181	2.50	3,135	6,225	3.72	1.98
1911-12†....	1,466	3,676	2.51	2,775	6,344	4.33	2.30
1912-13.....	1,438	3,463	2.41	2,598	5,656	3.93	2.18
1913-14.....	1,479	3,802	2.58	2,851	6,223	4.21	2.18
1914-15‡....	1,335	3,862	2.89	2,896	7,559	5.66	2.61
1915-16.....	1,128	3,247	2.88	2,436	7,309	6.48	3.00

*Sixteen months. †September 1911, pay of cleaners increased to $2.25 per day. ‡October 14, 1914, pay of cleaners increased to $2.50 per day.

James P. Beck.

James P. Beck, General Manager of the Portland Cement Association, with headquarters at 111 W. Washington St., Chicago, died Sept. 8 at the Presbyterian Hospital, Chicago.

Mr. Beck was born at Odell, Ill., on Jan. 27, 1886. He was graduated from the University of Illinois in 1907 with the degree A. B. in L. & A. He entered the employ of the Universal Partland Cement Co. in June, 1907. Two years later he was made publicity manager of that company by Edward M. Hagar, then president of the Universal Portland Cement Co. A little story in connection with this promotion to so responsible a position gives an insight into the business ability of the man who was taken away while yet almost youthful. Edward M. Hagar, it will be remembered, was the father of the Cement Products Exhibition Co., and while one of the cement shows was being planned became too ill to attend to details and transferred the responsibility to Mr. Beck with the remark, "Well, see what you can do with it." What Mr. Beck did on this occasion and on the numerous others which followed while he was identified with the Cement Products Exhibition Co., are too well known to need comment. His first as well as following efforts to make the Cement Products Exhibition Co. a success were noteworthy. Mr. Beck was also a prime mover in the two national conferences which were held in Chicago known as the National Conference on Concrete Road Building.

During his term at college, he was editor and manager of Illio, and manager of the Illinois Magazine. He was captain and regimental adjutant of the cadet regiment at the university and was president of the Illini Club, Chicago, for one year. He was a member of a number of clubs, associations and fraternities, among which were the following: Alphi Delta Phi, Phi Delta Phi, Phoenix, Varsity Club, English Club, Philomathean Club, Press Club, Advertising Association of Chicago, Cement Products Exhibition Co., American Concrete Institute, American Society for Testing Materials, University Club, Bobolink Golf Club.

During the fall of 1915, Mr. Beck was chosen to formulate plans for broadening the scope of work of the Association of American Portland Cement Manufacturers, the headquarters of which were then in Philadelphia. After several months' work, Mr. Beck submitted at the annual meeting of the association in December, 1915, a very comprehensive plan which was adopted essentially in its entirety. Mr. Beck was then made general manager of the association to put into effect and carry out the plan which he formulated. How successful this has been is known to everyone whose interests have kept them in touch with the rapid development of the cement industry and the work of the Portland Cement Association during the past two years.

Personals

Thomas B. Dornin has resigned as engineer in charge of the city water works of Norfolk, Va., to accept a position as marine architect with the United States Shipping Board.

J. Denny O'Neil of McKeesport, Pa., at present State Insurance Commissioner of Pennsylvania, has been appointed State Highway Commissioner to succeed Frank B. Black.

J. W. Greer of Beeville, Tex., has been appointed city manager of Bryan, Tex., succeeding W. Pipperman, who resigned to enter the reserve officers' training camp at Leon Springs, Tex.

B. K. Coghlan has resigned as associate professor of highway engineering at the Agricultural and Mechanical College of Texas. He is captain in the Engineer Officers' Reserve Corps and has been ordered to Ft. Leavenworth.

E. O. Francisco, who was assistant professor of civil engineering at the Agricultural and Mechanical College of Texas during the last session, has been commissioned a second lieutenant in the Engineer Officers' Reserve Corps and has been ordered to Fort Leavenworth.

Howard G. Kelley, heretofore vice-president of the Grand Trunk Railway, has been appointed president. Mr. Kelley commenced his railway career in 1881 on the Northern Pacific Ry., where he was engaged as assistant engineer on location, construction and bridge building. He was attracted from the railway to the mining field in 1884, engaging in mining operations until 1887, when he accepted the position of resident engineer and superintendent of bridges and buildings on the St. Louis Southwestern Railway System, including the St. Louis Southwestern Ry. of Texas and the Tyler Southeastern Ry. In 1890 he was appointed chief engineer of the St. Louis Southwestern System, a position which he held until March 1898, when he became consulting engineer of the same road, holding at the same time the position of chief engineer of the Minneapolis & St. Louis R. R. System and having charge of the construction and maintenance and real estate department. In 1900 his responsibilities were further added to by his appointment to have jurisdiction as chief engineer of the Iowa Central Ry. In 1907 Mr. Kelley joined the Grand Trunk Railway System as chief engineer, four years later being promoted to the position of vice-president. The American Railway Engineering and Maintenance of Way Association elected him president in 1905 and he presided over deliberations of that body until March,, 1907. Mr. Kelley has occupied the position of vice-president in charge of operating, maintenance and construction departments of the Grand Trunk Railway System from October, 1911, to date.

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Volume XLVIII. CHICAGO, ILL., SEPTEMBER 19, 1917. Number 12.

Should a Dynamite Charge Be Split Into Two or More Parts?

It has long been the custom of "powder experts" to insist that an explosive is more effective if concentrated at the bottom of the drill hole. While it may be true that a greater yardage of rock per pound of explosive can be broken in this manner, sight should not be lost of the fact that the resulting chunks of rock are often larger than those secured where explosive is also placed in the upper part of the hole.

In our last month's Dirt Mover and Pit Owner issue (p. 143) we gave the results of tests made in blasting limestone at Louisville, Ky., showing that the most satisfactory distribution of the dynamite (a 75 per cent grade) consisted in concentrating half the powder at the bottom and half near the top of each hole. Holes were spaced 7 ft. apart, and 0.4 lb. of dynamite per cubic yard of rock was used. The resulting chunks of rock could then be readily handled with a steam shovel.

There is food for thought in this successful departure from prevailing precedent.

Handling Boulders with an Orange-Peel Bucket

Nests of large boulders are commonly encountered in New England and, in fact, wherever ancient glaciers have deposited their burdens. A derrick equipped with an orange-peel bucket is often preferable to other means of handling boulders.

In constructing the Phelps Brook Dam near Hartford, Conn., a relatively small clam-shell (¾-yd.) handled boulders weighing as much as 7 tons. Of course it is practicable to dispense with a clam-shell and use chains, but the time lost in placing chains around the boulders is so great as to justify the purchase of a clam-shell if much of this work is to be done.

The Use of Air-Driven Chisels Instead of Hand Picks

In both trench and tunnel work the old pick and shovel method of excavation remains in use under certain conditions. But it is an open question whether the hand pick is longer justified for such work, provided the excavation is sufficient in quantity to justify the installation of a small air compressor and air hammers equipped with chisels.

In driving the Shore Tunnel of the Linwood Ave. Intake at Milwaukee, the contractors, O'Brien & Jackson Construction Co. of Chicago developed the use of "air chisels" for loosening hardpan and clay, and found them much to be preferred to hand pick work. Small size pneumatic chipping hammers were equipped with chisels having bits 1 to 4 ins. wide, the narrow bits for hardpan and the wide bits for clay. The bit is bent forward about 4 in. back of its cutting edge, and the air-hammer is held almost parallel with the face of the tunnel. In clay one bit would remove more than a shovelful. In this way the progress was increased fully one-third as compared with hand picking.

In the aggregate there is a vast amount of pick-work in trenches, which could be eliminated by the use of air chisels.

When It Is Cheaper to Drift than to Lift Dirt

A grader or "road machine" is commonly regarded as being a device not adapted for sidehill excavation, particularly if the cut is more than 2 ft. or 3 ft. deep. But it is possible, and often economic, to make sidehill cuts that are 6 or 8 ft. deep, using graders to push the earth sidewise from the cut to the fill.

A recent issue of The Earth Mover illustrated two Western graders drawn by a 75-H.P. Holt caterpillar tractor, on road work at Peoria, Ill. The winrow of earth left by the first grader is shoved aside by the second grader, so that one trip of the outfit serves to move the earth laterally about 10 ft.

A tractor and grader can be so operated that the tractor may travel on the partly graded roadway while the grader itself travels off to one side on the sloping ground that is being excavated.

The Equalization of Wages Throughout America

Not many years ago the wages of common laborers in the far west were nearly double those of laborers in the eastern states; but now there is a difference of only 25 or 30 per cent, and this difference bids fair to disappear in the near future. It was predicted that the opening of the Panama Canal would cause such an influx of European laborers that wages on the Pacific Coast would drop to the level of those on the Atlantic Coast. The war prevented such a flow of labor to the far west, and incidentally raised wages throughout the country, but proportionately more in the east than in the west.

Wages in the south have also risen, but to a less degree. The rise, however, seems likely to be more prolonged in the south, due in part to the shifting of a considerable part of the Negro population to the northern states. Contractors for southern work that will extend into next year should not lose sight of the fact that wages in the south are likely to continue to rise. The whole country seems to be headed toward a $3 daily wage for common labor, with no likelihood of a reaction even after the war ends.

What Is the Most Efficient Bit for Air-Hammer Drills?

In our last Dirt Mover and Pit Owner Monthly issue (Aug. 15) we published a three-page article giving in detail the results of drilling tests made under the direction of Prof. Carroll R. Forbes and Joseph C. Barton. The primary object was to determine the most efficient type of drill-bit for use with air-hammer drills, such as the "Jackhamer." There were four types of bits used—4-point (or cross), 6-point, Z-bit, and Carr bit. The rock was granite. The Carr and Z-bits "save one-third in drilling time over the 4 and 6-point bits." It was concluded that:

> Taking into consideration its cutting qualities, loss in gage, ease of making and tempering, the Carr bit seems to be far superior to all others, except possibly the Z when used at low pressures.

The Carr bit is illustrated and fully described in the recent edition of Gillette's "Handbook of Rock Excavation." The inventor of this bit undertook to design a bit that would drill a perfectly round hole of the same diameter from top to bottom. In granite, however, it is found expedient to decrease the gage of the Carr bit 1/16 in. every foot, which is only half the decrease necessary with 4 and 6-point bits.

Considering the economic importance of studying the shape of drill bits it is surprising that more tests have not been made and the results published. We commend to our readers a careful study of the article above mentioned.

Production of Explosives in 1916.—The total production, excluding exports, of explosives in the United States during the calendar year 1916, according to figures that the Bureau of Mines has received from manufacturers, was 505,415,052 pounds (252,708 short tons), as compared with 460,900,796 pounds (230,450 short tons) in 1915. The production for 1916 is segregated as follows: Black powder, 215,575,025 pounds; "high" explosives other than permissible explosives, 255,154,787 pounds; and permissible explosives, 34,685,240 pounds. These figures represent an increase of 17,852,725 pounds of black powder, 19,326,200 pounds of high explosives, and 7,335,331 pounds of permissible explosives, as compared with figures for 1915.

Over 8,600,000 25-lb. kegs of black blasting powder were used in 1916 in this country for mining and other purposes. Of the total 7,079,000 kegs were used in coal mining, 313,000 kegs in other mining, 428,000 kegs in railway and other construction work and 801,000 kegs for all other purposes.

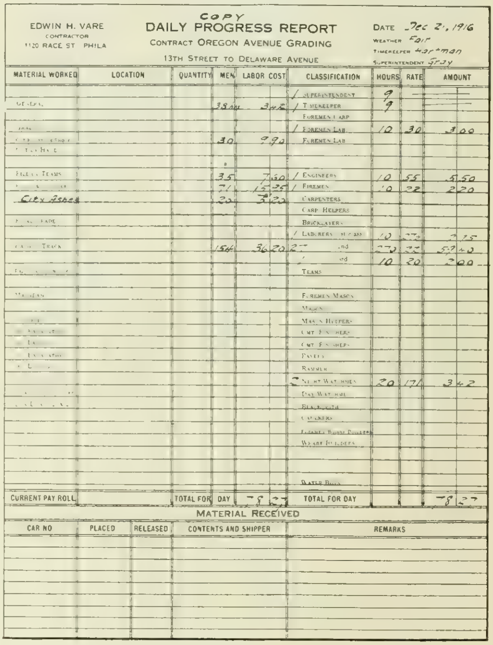
Simple Cost Accounting System Adaptable to Many Classes of Construction

By B. R. LEED,

Assistant Engineer Edwin H. Vare, Contractor, Philadelphia, Pa.

The cost accounting system described below was devised by the writer, and at the present time is being used on about a dozen contracts aggregating nearly $2,000,000.

A cost system of course must be accurate to be of any value. This system is checked against the payrolls as drawn, as to labor costs, and further, the payrolls are made up from the daily reports which form part of the system so that there is a double check on the labor costs. No bills for material are paid except they bear my approval, so that I have confidence in my figures on the costs of items.



EDWIN H. VARE
CONTRACTOR
1120 RACE ST PHILA

COPY
DAILY PROGRESS REPORT
CONTRACT OREGON AVENUE GRADING
13TH STREET TO DELAWARE AVENUE

DATE Dec 21, 1916
WEATHER Fair
TIMEKEEPER Hartman
SUPERINTENDENT Gray

MATERIAL WORKED	LOCATION	QUANTITY	MEN	LABOR COST	CLASSIFICATION	HOURS	RATE	AMOUNT
					/ Superintendent	9	—	—
[illegible]			38	3 42	/ Timekeeper	9		—
					Foremen Carp			
[illegible]					/ Foremen Lab.	10	30	3 00
[illegible]			30	9 90	Foremen Lab			
[illegible]								
[illegible] Teams			35	7 60	/ Engineers	10	55	5 50
[illegible]			71	15 25	/ Firemen	10	22	2 20
City Ashes			20	3 20	Carpenters			
					Carp Helpers			
[illegible]					Bricklayers			
					/ Laborers 1st class	10	[illegible]	[illegible] 75
[illegible] Track			154	36 20	27 [illegible] 2nd	270	22	59 40
					[illegible] 3rd	10	20	2 00
[illegible]					Teams			
[illegible]					Foremen Masons			
					Masons			
[illegible]					Masons Helpers			
[illegible]					Cmt Finishers			
[illegible]					Cmt [illegible]			
[illegible]					Pavers			
[illegible]					Rammer			
					2 Night Watchmen	20	171	3 42
[illegible]					Day Watchman			
[illegible]					Blacksmith			
					Caulkers			
					Foremen Wharf Builders			
					Wharf Builders			
					Water Boys			
CURRENT PAY ROLL		TOTAL FOR	DAY	78 27	TOTAL FOR DAY			78 27

MATERIAL RECEIVED

CAR NO	PLACED	RELEASED	CONTENTS AND SHIPPER	REMARKS

Fig. 1—Daily Report Form.

Labor.

Labor costs are first recorded and distributed by the timekeeper on the job. At the start of a contract the timekeeper is furnished with a list of items covering all the work contemplated in the contract. These items are numbered from one up for convenience in reference and recording costs. Some items are subdivided as seems necessary or desirable and these subdivisions also are given a number.

A daily report is made out by the timekeeper, on a form as shown in Fig. 1, and sent to the main office. Referring to this report it will be seen that the right-hand side gives the labor classification, hours, rates and amounts. The left-hand side of the report shows the distribution of labor. The totals on each side

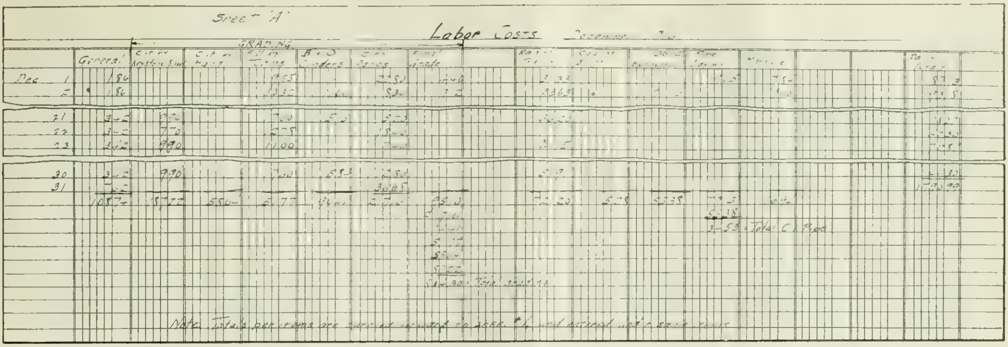

Sheet 'A'
Labor Costs
GRADING
General
Dec 1
2
21
22
23
30
31

Fig. 2—Sheet A: Daily Labor Costs for Month, Made up from Totals of Various Items on Daily Report.

must balance; that is, as indicated in Fig. 1, $78.27, was spent on different classes of labor, then the distribution per items must also equal $78.27, as shown.

On the reverse side of the daily report is made up the list of employes, giving names or numbers, hours, rates and amounts. It is from this that the paymaster makes up the payroll (referred to in the beginning of this article). Adding the amounts should give the same total as on the face of report, and this is the timekeeper's check against his labor classification and distribution.

From the daily reports, Sheet "A," shown as Fig. 2 is made up, by transferring the distribution of labor from the daily reports to the same items on this sheet. A glance at Fig. 1 and 2 will show how this is done by referring to the date, Dec. 21.

From Sheet "A" the totals for the month per items are transferred to Sheet No. 1 (see Fig. 4) and entered under same items. These monthly totals per items as entered on Sheet No. 1, are added to the previous current totals just above, giving the current totals for the period ended.

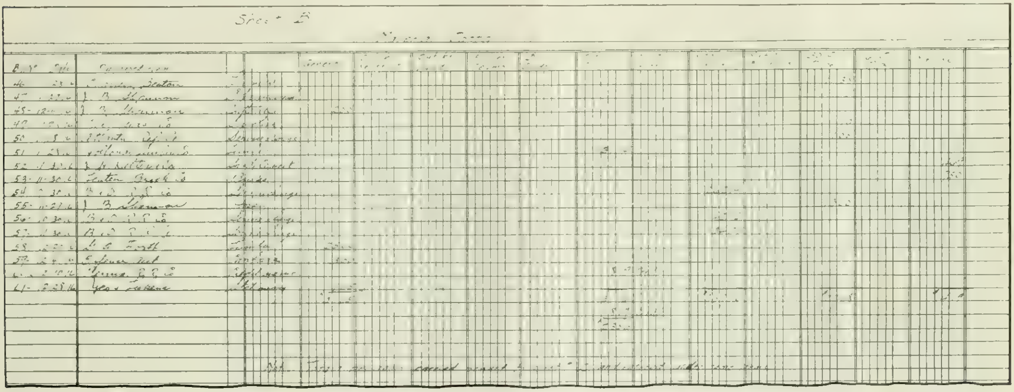


Fig. 3—Sheet B: Material Costs, Made up from Bills and Invoices.

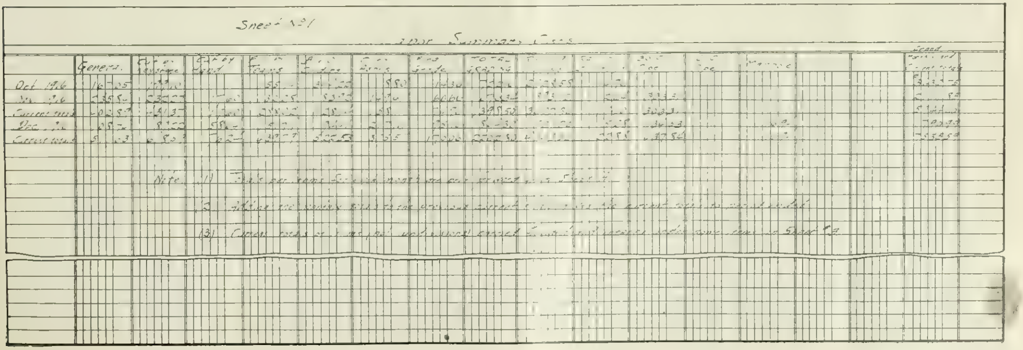

Sheet No 1
General

Fig. 4—Sheet No. 1: Monthly Labor Summary Costs.

After getting the new current totals, they are transferred to Sheet No. 3 (see Fig. 6) and entered under same items. This completes the cycle of steps in recording the labor costs.

This may seem like unnecessary work in making these three transfers of labor costs, as it could be done by one transfer from the daily report to Sheet No. 3, but in so doing it there would be no record for each month and, besides, the additions would be done, anyway, perhaps on scraps of paper that would not be kept, and if at any time it would be necessary to refer back, there would be no record of the steps by which the figures were obtained.

My way may be longer, but I am able to go back to any month and any day of the month if I want to trace any particular labor distribution.

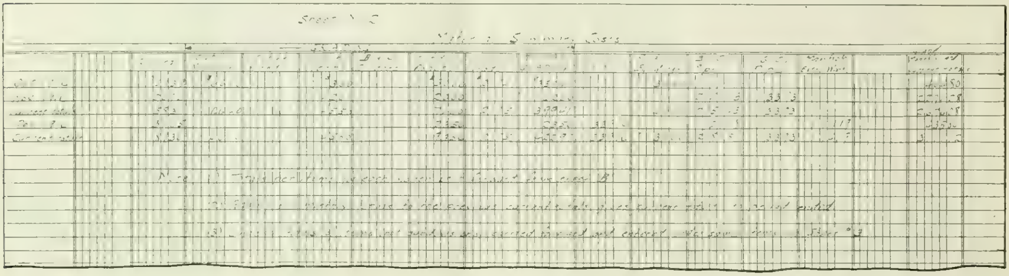


Fig. 5—Sheet No. 2: Summary of Monthly Material Costs.

Materials.

All bills and invoices are sent to the field offices for checking and distribution by the timekeeper.

When returned to the main office, they are entered on Sheet "B" (Fig. 3), and distributed to the various items as indicated by the timekeeper. As each bill is entered it is given a number, and this number serves to show that the bill is entered and reference can be made back any time.

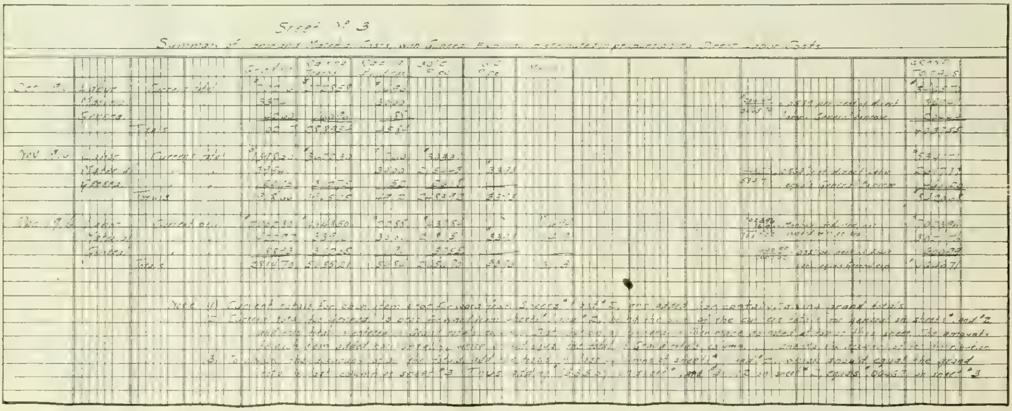


Fig. 6—Sheet No. 3: Summary of Labor and Material Costs.

The distribution per items are added up at the end of the month, the totals carried forward and entered on Sheet No. 2 (see Fig. 5) and added to the previous current totals, just above, giving the current totals for the period ended. The current totals are transferred to and entered under same items on Sheet No. 3 (see Fig. 6). This sheet gives the complete current costs and each month is complete in itself as the amounts thereon are not added to previous totals as on Sheets No. 1 and 2, as this has already been done, though separately for labor and material on Sheets No. 1 and 2.

The system, in brief, consists of the three columnar loose sheets, Nos. 1, 2 and 3, with Sheet "B" and the daily report as the sources of information and Sheet "A" as an intermediate though necessary link to preserve the record complete. I have noted on the various sheets the steps necessary in using the system and a study of these will show any one able to keep costs the "how" of it, without reading all that I have already described and tried to explain.

Columnar sheets, 11x17 in., in loose form are used. For additional columns for items, sheets are joined endwise with adhesive tape.

The general charge shown on the different sheets includes expenses which apply to the contract as a whole and are distributed as noted on Sheet No. 3.

On some contracts an item is carried for plant. To this is charged machinery and tools. This item is distributed by the same method as general charge and sometimes combined with general if it is a small account. The entire amount for plant may not be charged against any one contract, but only the amount determined that the plant has depreciated and interest charges.

Drag Line Excavator Digs Tail Race and Fills Crib Dam

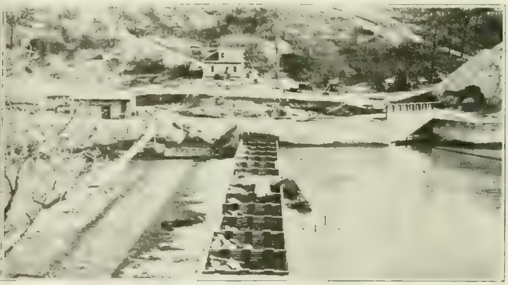
That a drag line cableway excavator can be made to perform a variety of operations effectively was demonstrated during the construction of a tail-race and crib dam for a hydro-electric plant on the Niobrara River, near Valentine, Neb.

The excavator first dug the tail-race, a canal 30 ft. wide and about 300 ft. long, involving 22,000 cu. yd. of excavation in hard clay. Then the cableway was set up to span the main river channel and was used to convey and dump the stone into the cribs and the backfill on the upstream side of the cribs.

The canal was dug through Brule clay, requiring dynamiting. This Brule clay shoots hard as it has no strata, and even 40 per cent dynamite is too fast for it. Black powder could not be used as the clay is full of water.

The method followed was to shoot along one edge of the canal and while the bucket dug there the drillers would work on the other edge. Thus the excavator first dug two ditches, 30 ft. apart, leaving a hard core in the center which was taken out much more easily than the same amount of material could have been excavated if the bucket had been worked off a face. Besides, this way of working forced the bucket out along the edges, resulting in the straight banks shown in the accompanying view of the completed canal.

Tail Race Dug by Drag Line.



Filling Crib Work by Means of Drag Line.

The excavating required 35 10-hour days, including time lost each day dodging the drillers. The excavator moved a load every two minutes when digging at the end of the canal nearest the cableway mast and every four minutes when digging at the far end of the canal.

The machine was a Sauerman dragline cableway excavator with ½-yd. Sauerman bucket operated by a 2-drum American friction hoist. The operating crew consisted of engineer and fireman, signal man and four drillers. The cost of digging the canal, according to Mr. Fred B. Ryons, who superintended the work, was about 20 ct. per cubic yard. The cost includes about $1,000 for dynamite.

The excavator was equally useful when the cableway was reset spanning the stream and the bucket was worked backwards to carry out the stone and backfill for the crib.

The material for the backfill was taken from the pile of clay excavated from the canal, moved by wheelers and dumped near the foot of the cableway mast. By releasing the tension cable the engineer dropped the bucket onto the material at the foot of the mast and filled the bucket by starting the front drum of the hoist controlling the full cable. With the bucket loaded, the tension line was taken in on the rear drum, the brake on the front drum is released and the bucket traveled down the cableway by gravity. It was dumped automatically by striking a clamp which tripped the dump chain. The location of the dump had to be changed three or four times a day, which was done by simply lowering the track cable so that a man standing on the crib could loosen the dump clamp and move it along on the cable. The backfill was placed at the rate of 20 yd. an hour. The stone for the crib was hauled from a distance, loaded into the bucket by hand and placed in the crib by the same method as the backfill was placed. The stone was handled at the rate of 10 yd. an hour.

Miami Conservancy District of Dayton, O., Calls for Bids on 15,000,000 Cu. Yds. of Earth Work and 257,000 Cu. Yds. of Concrete

Bids are now being asked on the first contracts for the $23,000,000 flood prevention project of the Miami Conservancy District, of Dayton, O. The work advertised calls for about 15,000,000 cu. yd. of excavation and embankment and 257,000 cu. yd. of concrete. The contracts cover the dams for the retarding reservoirs on the Miami, Mad and Stillwater Rivers and the Twin and Loraine Creeks, and also a considerable amount on river channel rectification at Dayton and Hamilton.

Bids are asked on 12 contracts, the approximate quantities on each job being as follows:

DAMS.

Contract No.	Work.	Excavation, cu. yd.	Embankment, cu. yd.	Concrete, cu. yd.	Paving and riprap, cu. yd.	Iron and steel, tons.
1.	Germantown Dam...	200,000	850,000	20,000	1,000	120
2.	Englewood Dam....	375,000	3,500,000	38,000	2,000	180
3.	Lockington Dam...	200,000	1,000,000	37,000	1,000	50
4.	Taylorsville Dam...	750,000	1,100,000	57,000	5,000	100
5.	Huffman Dam......	360,000	1,100,000	45,000	1,500	400
	RIVER IMPROVEMENT.					
		(1)	(2)	(3)		
41.	Miami at Dayton..	....	65,000	......	....	...
42.	Miami at Dayton...	850,000	80,000	25,000	.....	...
43	Miami at Dayton...	465,000	205,000	3,500	.....	...
44.	Miami at Dayton...	1,000,000	655,000	2,000	.....	...
45.	Mad. at Dayton....	20,000	35,000	1,500	.....	...
46	Wolfe at Dayton....	80,000	25,000	1,400	.....	...
48	Miami at Hamilton.	1,900,000	......	27,000	.....	275*

(1) Channel excavation. (2) Levee embankment. (3) Concrete in retaining walls and revetment.

*Reinforcing steel.

The bids will be received until 2 p. m., Nov. 15, by Ezra M. Kuhns, secretary Miami Conservancy District, Dayton, O. Arthur E. Morgan is chief engineer of the district.

Methods and Costs of Cross Cutting in Mines of Amador County, California

Important factors in cross cutting based on actual mining operations are outlined by Mr. Edwin Higgins in a bulletin issued on July 1 by the California Metal Producers' Association. The data are the result of an investigation conducted at the mines in Amador County, California. The matter following is taken from the bulletin.

A summary of the data relating to the driving of 10 cross cuts in various California mines is given in Table I. In this table costs are figured only on labor and explosives, the following charges being made for labor: Drill men, $3; chuck tenders and muckers, $2.50.

All the cross cuts are in the hard greenstone of Amador County except operation No. 8 (hanging wall slate), operation No. 9 (andesite and schist) and operation No. 10 (slate). Five degrees of hardness were selected, No. 5 being the hardest. Most of the rock encountered was uniformly hard.

TABLE I.—DATA RELATIVE TO THE DRIVING OF TEN CROSS CUTS IN VARIOUS CALIFORNIA MINES.

No.	Hardness of rock, 1-5.	Distance driven, Ft.	Size of cross cut, Ft.	Ventilation.	Average length of tram, Ft.	Grade of track, Per Cent.	Type of drill used.	Kind of bit.	Air pressure at drill, Lbs. per Sq. In.	Depth of holes, Ft.
1	5	94	6 x8- 7 x9	Fair	Various	1.5	Piston	Cross	85-90	5½-6
2	5	346	7 x9	Fair	Various	1.5	Water Hammer	Carr	85-90	5½-6
3	4	100	5 x6½	Good	1000	...	Water Hammer Stoper	Carr	90	5
4	4	500	6 x9½	Fair	275	0.2	Water Hammer	Carr	90-95	5
5	4	427	5½x7	Poor	1318	5	Water Hammer	Cross	70-90	5 -6
6	5	172	7 x9	Poor	140	0.66	Piston	Cross	75	5 -6
7	4	357	7 x9	Poor	180	0.5	Piston	Cross	80	5½-7
8	3-4	450	5 x6 7 x9	Poor	2190	0.84	Piston	Cross	80	6
9	4-5	150	6 x7½	Fair	85	...	Water Hammer	Cross	90	5 -6
10	3	432	5 x7	Poor	210	1.5	Piston	Cross	85	5

No.	No. of holes per round.	Shifts to drill round.	Advance per drill shift, Ft.	Shifts worked per 24 hrs.	Days pay, Contract.	Kind of fuse used.	Str. of cap.	Kind of powder used.	Lbs. powder per round.	Cost per ft. labor & explos.
1	15-16	3	1.5-2	2	DP	Comet	6x	30% Ammo-Gel.	62	$6.12
2	15-16	1-1½	4	2	DP	Comet	6x	30% Ammo-Gel.	62	3.82
3	16	1	4.25	1	DP	Delay Expl.		35% Gel. Dyn.	50	3.62
4	16	1	4.5	2	DP	Delay Expl.		35% Gel. Dyn.	50	3.42
5	11-13	1¾	2.60	1	DP	Eclipse Special	6x	40% Gel. Dyn.	30	4.38
6	15	2	2	3	DP	Pacific	6x	40% Ammo-Gel.	50	5.87
7	12	1	5	2	C	Pacific	6x	40% Ammo-Gel.	62	3.94
8	11	1¼	3.66	3	DP*	Aneroid	6x	40% Nit. Gly.	30	4.07
9	12	5/8 6/8	5	3	DP	Pacific	6x	35% Ammo-Gel.	38	3.07
10	8-10	5/8	4.5	1	C	Pacific	6x	40% Ammo-Gel.	30	3.36

---

*Bonus paid: Machinemen received $3 per day; chuck tenders and muckers $2.50 per day. For every 5 ft. over 50 ft. per week, all men received 25 ct. per day additional.

For fear of creating an erroneous impression regarding the use of some particular drill, it was decided not to mention the make, but simply to divide the drills into two classes, piston drills using solid steel, and hammer drills using water through hollow steel. In practically all of the operations 1-ton, steel, end-dump cars were used, and shoveling was done either from a steel sheet or from planks. Hand-tramming was used in all of the operations except No. 3, in which mules were used. The track gage in all cases was 18 in., and 16-lb. rails were used except in operations Nos. 6 and 10, where 12-lb. rails were used. No timber was used, except in operations Nos. 5, 6 and 7, which required a few sets each.

Additional Notes on the Various Operations.

Operations No. 1: This work was done in 1915, the cost of the 94 ft. being as follows:

	Cost.	Percentage of total cost.
Drilling (labor)	$ 295.25	41.2
Mucking and tramming	192.50	26.8
Supplies	48.50	6.8
Powder (at 11 ct. per lb.)	181.45	25.2
Total	$ 717.70 or $7.63 per ft.	

Operation No. 2: Of the 346 ft., 239 were driven in 1916 and 107 ft. in 1917. The 1916 costs were as follows:

	Cost.	Percentage of total cost.
Drilling (labor)	$ 785.25	31.4
Mucking and tramming	583.25	23.3
Powder	946.45	37.9
Track, ties and incidentals	186.43	7.4
Total	$2,501.38 or $10.46 per ft..	

The costs during 1917 (107 ft.) were as follows:

	Cost.	Percentage of total cost.
Drilling (labor)	$ 292.00	27.6
Mucking and tramming	327.00	30.9
Supplies	84.20	8.0
Powder (at 17 ct. per lb.)	354.20	33.5
Total	$1,057.40 or $9.88 per ft.	

Operation No. 3: Firing was done electrically from a 110-volt line with switch, using delay exploders.

Cycle of Operations: Machineman goes to work at 7:00 a. m., finding clean set-up. He drills and shoots at about 3:00 o'clock. Two muckers go on at 7:30 p. m., muck out, clean up and put in platform for next shift. All drill parts are kept available in duplicate.

Operation No. 4: Practically same cycle of operations as No. 3, except that two shifts are worked. Machineman comes on to a clean set-up, drilling and shooting about 3:30 p. m. Two muckers come on at 4:00 p. m. and muck back for a clean set-up. They muck out their round, machineman coming on at 7:00 p. m. He drills and shoots at about 3:30 a. m. Two muckers come on at 4:00 a. m. and muck back so that a machineman coming on at 7:00 a. m. will have a clean set-up.

Since this work was done a change has been made which has resulted in greater efficiency. The 1¼-in. round, hollow steel, with cross bit, one set of which sufficed to drill only one hole, has been discarded in favor of 1-in. hexagon, hollow steel, with Carr bit. Drilling speed has increased 25 per cent or more and the new steel drills from five to eight holes without resharpening. The drill has been equipped with a striking block, or anvil block.

Operation No. 5: Most of this work was done with one drillman on the first shift and one mucker on the second shift. The 426.5 ft. were driven in the period from July, 1916, to February, 1917, at the following cost:

	Cost.	Percentage of total cost.	Cost per foot.
Timbering	$ 51.88	1.8	$0.12*
Drilling	1,084.16	36.9	2.54
Mucking and tramming	521.73	17.8	1.22
Explosives	670.48	22.8	1.59
Candles	18.60	0.6	0.04
Hoisting	591.10	20.1	1.38
Total	$3,937.95	100.0	$6.89

---

*Not timbered throughout.

163.5 drill-shifts were worked, which gives an average advance of 2.6 ft. per drill shift.

Operation No. 6: The cost for the 172 ft. was $1,255 ($7.30 per ft.), which does not include air, hoisting, drill sharpening or superintendence. The work was done in July, 1916.

Operation No. 7: Drillers and muckers made from $4 to $4.50 per foot on contract. Ventilation was by compressed air, with water spray used after shooting.

Cycle of operations: Driller, chuck tender and two muckers came on at 7:00 a. m. Machine was set up for back and breast holes and muckers started mucking. By noon the round was half drilled and the muck was all out. After dinner the round was finished, muckers putting in track and platform. Shot at 3:20, blowing out with compressed air. Next shift comes on at 6:00 p. m. and has the same cycle of operations.

Following is detailed cost per foot:

Drillers (2)	$ 2.78
Trammers and shovelers	2.22
Timbermen	.30
Powder	2.42
Fuse	.19
Caps	.06
Candles	.10
Timber	.36
Power	.58
	$ 9.01

Cost per foot for 1,015 ft. of drifting under all conditions; all timbered and from soft to very heavy ground:

Drillers	$ 3.90
Engineers	.12
Trammers and shovelers	3.81
Timbermen	1.20
Powder	1.19
Fuse	.13
Caps	.05
Candles	.20
Timber	1.90
Power	.60
	$ 13.10

Operation No. 9: Detailed cost for 150 ft. of cross cut:

Explosives	$ 142.00
Steel	20.00
Timber	37.30
Pipe	22.50
Air	20.00
Labor	993.60
Total	$1,235.40 or $8.24 per ft.

Track, superintendence, surveying and power bring the total cost up to $10.34 per foot.

Cycle of Operations: Start setting up horizontal bar and machine at 7:00 a. m. Top holes drilled by noon and by the time muckers had the previous round mucked out; would then tear down and set up for the lifters. Round would be ready to shoot by 2:00 p. m. This operation continued for three shifts.

Operation No. 10: The best progress was 53 ft. over a 10 day period, or at the rate of 160 ft. per 30 days. The average rate was about 120 ft. per month. Actual drilling time for a round was 5 hr., setting up and tearing down taking up 2 hr.

Expenses over a distance of 100 ft.:

700 lb. power, at 17 ct.	$ 119.00
220 caps, at $1.30 per 100	2.86
1320 ft. fuse, at $5.20 per 100 ft	6.86
160 lb. steel, at $0.093 ct. per lb.	14.90
100 ft. 2-in. pipe, at 16 ct. per ft	16.00
Contract 100 ft., at $4.50 per ft.	450.00
Air	20.00
Total	$ 629.62 or $6.30 per ft.

Track, superintendence, surveying, assaying, apportionment of power, hoisting, etc., bring the cost up about $3.60 per ft., making the total cost $9.90 per ft.

All drilling and shooting was done on day shift. Mucking and laying planks and track was done on night shift.

378.5 man-shifts were worked, or 153 shifts day and night.

Comments on the Various Operations.

Nos. 1 and 2: These two operations afford a fair comparison of the solid-steel, piston drill, as compared with that of the water hammer drill. The 94 ft. of operation No. 1 were driven with a piston drill, 5 shifts being required to put in a round of holes. At this point (see operation No. 2) a change was made to the water-hammer drill, after which a round of holes was drilled in from 1 to 1½ shifts.

Attention is directed to the greater percentage of total cost chargeable to drilling in operation No. 1, as compared with No. 2. The increased cost of explosives and supplies in operation No. 2 is due largely to the increase in the cost of these materials in 1916 and 1917.

No. 3: This is one of two operations out of the ten in which delay exploders were used. A minimum of misfires occurred and results were reported better than blasting with cap and fuse. This cross cut was run with a hammer stoper and good progress was made. The section of the drift was small compared with the other operations. It was reported that the fact that drilling was done on one shift and mucking on the next made for economy, but not speed. Keeping of drill parts in duplicate was an important factor in lessening delays.

No. 4: This was an efficient operation. Note that the muckers came on three hours ahead of the drillers. A very important bit of information was brought out at this mine, namely: the change from 1¼ in. hollow, round steeel, with cross bit, to 1-in. hollow, hexagonal steel, with Carr bit, which greatly increased the drilling speed and the number of holes that could be drilled with one set of steel.

No. 6: The striking feature here is the slow progress made with the solid-steel, piston drill.

No. 7: This is a case in which good progress was made with the piston drill. However, the ground was not of the hardest at all times and the fact that the work was done on contract had some effect on the speed. The detailed costs are interesting.

No. 8: This operation is a striking illustration of what can be done in cross cutting by day's pay plus a bonus. An average of 77 ft. was made every week. A little figuring will show plainly that the company was the gainer by paying the bonus.

No. 9: This operation showed the lowest cost in labor and explosives.

No. 10: The total cost shown for this operation was abnormally high, for the reason that there was no other work being done in the mine and all charges were directed towards this one cross cut. The progress was excellent, but on account of the fact that the ground was not as hard as any of the other operations it is hardly fair to use this operation in comparison with the others.

As indicated previously, it is believed that Operations 1 and 2 afford the best comparison between the solid-steel, piston and the water-hammer drills. However, one such operation cannot be taken as conclusive. While comparisons from the table are by no means accurate, on account of varying conditions, it is of interest to note the following: Omitting operation No. 10, the average number of shifts required to drill one round of holes was 1.81 for solid-steel, piston drills, and 1.14 for the water-hammer drills. The average advance per drill-shift was 3.10 ft. for the piston drills, and 4.07 ft. for the water-hammer drills. The average cost per foot in labor and explosives was $5 for the piston drills, and $3.66 for the water-hammer drills.

Making a further distinction, the average cost per foot in labor and explosives shows $3.62 for the water-hammer drills using the Carr bit; $3.72 for the water-hammer drills using the cross bit, and $5 for solid-steel piston drills, with cross bit.

Important Considerations.

Based on the information secured during this investigation, the following conclusions and suggestions are offered:

In the hard greenstone and slate found in the Amador County mines, the water-hammer type of drill is superior to the solid-steel piston drill.

Apparently the Carr bit does faster work in this rock.

Working by day's pay with a bonus makes for speed and economy.

The use of 1-in. hollow, hexagonal steel, with Carr bit, as against 1¼-in. hollow, round steel, with cross bit, makes for speed and economy.

It was brought out that in an operation the same progress was made by working two shifts as had previously been made working three shifts. This was due chiefly to the fact that the ventilation was very poor. The further fact was brought out that in poorly ventilated headings the efficiency of the men is often impaired, and sometimes they are entirely overcome, by powder gas. It appears that this trouble is more acute where the rock is hard. Best results seem to have been attained by blowing out the heading with a combined air and water spray after blasting. Where water is available the muck pile should be sprayed from time to time, as an aid in keeping down powder gas.

Inasmuch as the prime factor in drilling efficiency is the force and frequency of the blow struck by the drill, it is of importance to keep compressors working up to efficiency and to watch carefully for leaks in the air line so that the proper pressure may be maintained at the drill.

Drilling economy may be secured by conducting experiments on the proper strength and amount of powder to be used, the kind of bit to be used and the proper number, angle and size of drill holes.

Electrical blasting is recommended where current is available.

The keeping of detailed costs on each operation enables the operator to estimate closely the cost of proposed work. It also affords a check on work in progress, the operator at any time being able to locate any item that might be causing an unnecessary increase in cost.

Costly delays may be eliminated by keeping duplicate drill parts close at hand.

Misfires are a most important factor in causing delays. It is recommended that records be kept of misfires so that remedial measures may be taken should they exceed 2 per cent.

A good drill-steel blacksmith is an absolute necessity for efficient work.

Ordering, Transporting, Handling, Setting and Driving Sheet Piling for Cofferdam for 1,000 ft. Pier

In the construction of the 1,000 ft. pier at West 46th St., New York City, a cofferdam of Lackawanna steel sheet piling was employed. This cofferdam was a cellular structure, designed for a pressure head, of soft mud and water, of about 65 ft. The cellular spaces were filled with earth and clay to form the water seal, and were held against external pressure by an embankment of riprap or broken stone. The steel sheet piling forming the cellular spaces was in single pieces, many of which were more than 70 ft. long. The various features in the design and construction of this cofferdam were described by Mr. Charles W. Stamford in a paper[*] presented March 7, last, before the American Society of Civil Engineers. In a discussion of the paper in the August Proceedings of the Society, Mr. F. E. Cudworth describes the practical details of the ordering, transporting, hauling, setting and driving of the steel sheet piling.

Fortunately for the ordering, the Department of Docks and Ferries had complete data, as a wooden pile with a steel shoe had been driven at the corner of each cell or pocket, down to rock. From the rock elevation thus obtained, and assuming a plane surface between the corners, a schedule of piles were made up in lengths varying by 3 in. There were finally more than 3500 piles in the order. If any one has a similar order to make up, it would be better to use 1 ft. as the variation in length, so as to have to deal with a less number of different lengths.

After giving the matter some thought, it was decided to record the pile data on loose leaves in book form, of a size that could be readily carried in the pocket. The pages contained the necessary information for the rolling mill, the contractor, and the Dock Department, and copies of the books were sent to all parties concerned. As each then had the same information, correspondence and conversation could be readily carried on.

The Lackawanna pile, in cross-section, is symmetrical as to the ends, but not the sides, therefore, the names of "right hand" and "left hand" were adopted, on account of the resemblance of the cross-section to the hand, when looked at from the thumb side. All specials were made by splitting the piles and using the halves, so that the end section must present a certain outline to suit the closing of a pocket with a fixed number of piles—if an odd number, one outline, if an even number, a different outline—so this end section had to be shown also. The number of piles in the side of a pocket was finally decided on as an even number. This made the three wings of a Y-pile show right-handed in plan. The book solved this problem, as it gave the same information to all persons connected with the work, from the mill to the foreman who drove the piles, and the officials who inspected them.

The next problem came in the handling. On the first few cars the piles were in no particular order, different cars even became mixed on the railroad lighter and in handling them from the railroad lighter to the contractor's lighter, or to the scows on the work, so that finding a pile of the required length was quite a task, and the loss of time increased the cost. The manner of handling the piles was discussed by the contractor's force and the railroad company, and finally it was arranged to have the piles loaded in the reverse order to that in which they were to be driven. The piles were stacked in groups of about eleven pieces each, with a maximum weight of about 11 tons per group. These groups were put on two cars, three groups sideways and two groups high, separated both horizontally and vertically by blocking, so that the groups were unloaded as units in Jersey City. The groups were then transferred in wire rope slings from the railroad lighter to the contractor's lighter or to a scow, from which they could be lifted one at a time by the contractor's lighter. As each single pile was placed, the next one wanted was found on the top of the group, and from one group they went to the next, and so on. This brought order and economy, whereas, at one time it was thought that a large piece of ground would be required for sorting, with a crane or a lighter to do the work.

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[*] Unusual cofferdam for 1,000 ft. pier, New York City. Proceedings Am. Soc. C. E. Vol. XLIII, No. 2, pp. 115-159.

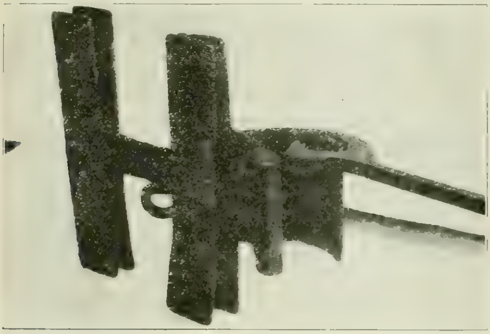


Fig. 1—Guide for Entering Pile.

The next operation was setting the piling. A lighter was brought from Boston for this purpose, but, in sketching it in on the plan at the time the piling was ordered, it was found that the round corner of the coffer would not admit of placing the lighter so that it could do the work. To accomplish this, and also drive the clusters of land piles for tying back the cut-off wall, two booms were put on a floating pile-driver; this was done in order to avoid bringing in a land driver for a few clusters; one boom held the leads and hammer and the other handled the pile. In this way the land piles could then be driven and the lighter could be taken into the round corner of the dam "head on," in order to set the steel piles. The driver had little freeboard, but this was remedied by closing the forward hatch to keep the water from flooding the hold.

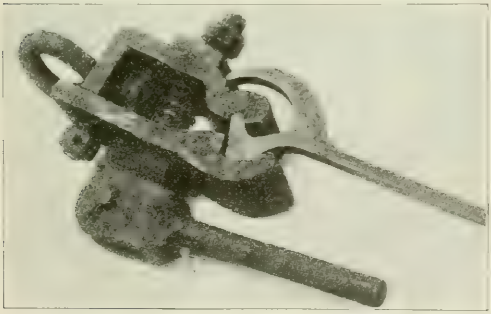
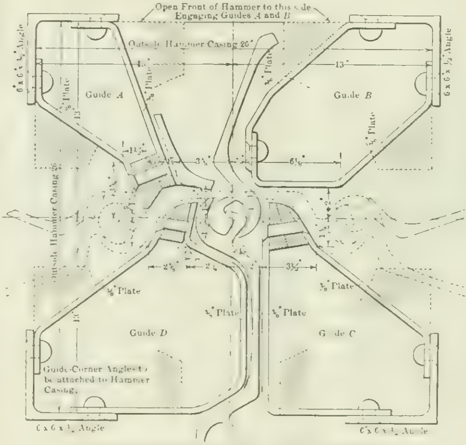


Fig. 2—Spring Clamp for Attaching Tag Line to Pile.

It might be thought that the setting of the piles could be done easily, but, with the end of the previously driven pile 20 ft. above the water, and with a pile from 50 to 70 ft. long swinging in the air from a boom, and the pile-driver or lighter moving with the wind and boat swells, it will be realized that it was quite difficult. It is necessary to enter the Lackawanna pile from the end, and as the clearance is only ⅛ or ¼ in., this is not easily done, and there is a chance that the man guiding the pile may lose a finger or two. Light ladders, with a strong hook in the side, so that they would hang to the top of the pile, were provided, and were better than a boatswain's chair, as the man was on something more nearly stationary. The next thing was to steer the pile into place. Various schemes were suggested, and finally a guide (Fig. 1) was made from a piece of piling about 5 in. long, with a swivel-eye for a safety line, so that it would not be lost if it fell overboard. This guide was held in place on top of the pile with light flat-jaw pieces on each side, and had the "thumb," as that part of the lock on the pilings was called, cut out. The weight of the guide was reduced to 11 lb. by cutting. An operator, skilled in handling a lighter, could lower the pile within the distance of the height of this guide; it could then be pulled into place, and would be held by the "finger" of the guide until lowered. This was a time saver and good accident insurance.



HORIZONTAL CROSS-SECTION LOOKING DOWNWARD

Fig. 3—Attachment to Hold Hammer on Pile.

The tag line at first was tied to the lower end of the pile, and two men on two lines held the swing of the pile, and helped the guide man. It took time to put on this rope, and more time when the pile was up in the air, to take it off. A little spring clamp (Fig. 2) was finally made, with a swivel-eye for attaching the tag-lines. The clamp was fastened to the pile with a screw bolt having a lever handle, and this could be put on and taken off in a few seconds. The weight of the clamp was 14 lb.

The best day's work in setting, with one lighter, after the crew had been well broken in, was in one case 98 pieces 70 ft. long, and in another case 129 pieces, from 20 to 25 ft. long, in 8 hours. In the latter instance the average was 16 piles per hour, or a pile in a little less than 4 minutes. Thus, seconds cut off in different ways were important.

After the setting came the driving. The idea was to use the pile-driver boom and the lighter boom, and do away with the clumsy hanging leads. This is difficult, even when the suspension is from a land machine, but, with a floating machine, moving around and bobbing up and down, it is still more difficult. The first trouble was to get the hammer on the pile when up in the air, the next to keep it there, and lastly (but still important), to keep it correctly lined up with the pile, so that the blows would be in the right direction to do the most good.

Finally, an attachment was designed to be placed on the corners of the hammer. This projected like a double clothes-pin. The hammer was the body of the clothes-pin and the attachments were the prongs. This was built in iron and later in wood. Fig. 3 shows the design for the arch-web style of pile; the arrangement for the straight-web pile section was similar. A double set of prongs—making two slots—was used, so that, by placing the piles in one slot, either three or one could be driven, and by using the other slot, two piles could be covered. The idea was to drive three piles at a time when they drove easily, then two piles, when the driving was harder, and finish by driving one pile at a time, with a follower. This arrangement worked well, and allowed the lifting tackle to be even entirely slacked off, if desirable. In fact, the hammer would work on the pile without being otherwise supported.

Grade Separation

The following suggestions on handling grade separation problems are given in the recently issued supplement to the manual of the American Railway Engineering Association:

Whenever grade separation through densely built-up thoroughfares (short blocks, say, 12 to 15 crossings per mile), becomes imperative, elaborate studies of the kind and volume of traffic on each thoroughfare should be made and due record kept, with a view of eliminating or vacating certain of these crossings as wholly unjustifiable from a cost standpoint, and lateral streets at a less cost may be opened in their stead.

If but a very few crossings are to be eliminated in an industrial district, with reasonable assurance that no others will be required, other things being equal, the method used should not disturb the tracks.

If several crossings are to be eliminated in an industrial district, other things being equal, the most efficient method is by track elevation.

In a residential district, if grades and other conditions on the railway will permit, complete depression, allowing the streets to remain at their original level, or nearly so, is the preferable method.

Slopes for High Rock Cuts.—The American Railway Engineering Association has adopted the recommendation of its Roadway Committee that rock cuts of 40 ft. or more in height should be constructed at slopes of ¼ to 1.

Steam Shovel Operation in Mining Bituminous Coal*

Steam shovels operate either in a circular path beginning at the outside of the area and gradually working inward spirally until an area or island is left in the center about which the shovel cannot be economically moved (see Fig. 1).

This method is used mainly by the old type fixed shovels to avoid turning the shovel, but with the modern revolving shovel this necessity is obviated and such shovels make first a through cut in a straight line across the property (Fig. 2), dumping the spoil on the surface, and after reaching the boundary return on a parallel cut, dumping the spoil in the excavation from which the coal has been meanwhile removed, either by hand or by a smaller steam shovel.

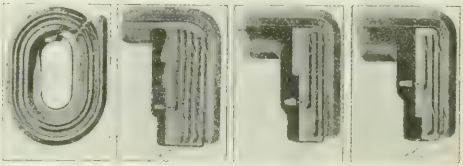


Fig. 1. Fig. 2 Fig. 3. Fig. 4.

Fig. 1.—Methods of Steam Shovel Operations in Coal Mining.

The details of the parallel cut method can be modified as shown by Figs. 2 to 4, and as necessitated by the shape of the property, drainage, depth of overburden, etc.

Figures 3 and 4 show two such modifications of the ordinary parallel system. The first cut is made close to one of the property lines and extends across the property. At the far end cuts are made at right angles extending to the other property line. When the shovel reaches the far property line it reverses its direction and returns parallel to the previous cut. The cross ridges shown in Figs. 3 to 4 are made when the shovel turns into the bank to begin the return cut. After the shovel has dug in the proper distance in beginning the cut, it digs back to uncover the triangular piece left in opening up the cut. In Fig. 3 the small loading shovel is shown following the digging shovel and there is a curve in the loading track laid on top of the coal. This curve must be continually moved forward as the loading shovel advances and is, therefore, a constant source of expense and trouble. In Fig. 4 the digging shovel follows the loading shovel; the loading track is continuous along the coal face and therefore does not require changing.

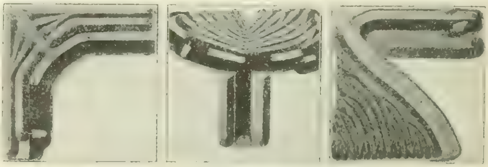


Fig. 5. Fig. 6. Fig. 7.

Figs. 4-7.—Modified Methods of Making Corner Openings.

Figure 5 shows a stripping field opened from the corner and having a diagonal haulway. The shovel starts from the upper left-hand corner and makes the first cut along one property line, depositing the spoil away from the boundary line. It then returns to the starting corner and on its next cut dumps the spoil from this cutting and about one-half of the waste bank from the thorough-cut against line so as to prevent caving along the line. Then returning again to the original starting corner, a second thorough-cut is made at right angles to the first, a gap being left between the ends of the spoil bank at the starting corner to provide for future haulage. In order to avoid right-angle turns with the shovel, wedge shaped cuts are taken off from the starting corner as indicated and soon a continuous face is formed, giving easy turns for the shovel. With such an arrangement two small shovels can be used, both loading coal or, if there is an underlying fire clay, as sometimes occurs, the second shovel can load fire clay. If the underlying material is of value, a larger output of coal can be obtained by using two stripping shovels and two loading shovels, but in this case it would not be necessary to provide for the small wedge-shaped cuts, as neither of the shovels would have to then make a right-angle turn.

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*From a paper prepared by H. H. Stock for presentation at the St. Louis meeting of the American Institute of Mining Engineers. The complete paper is printed in the September Bulletin of the Institute.

Figure 6 shows a somewhat similar method of opening up by running the thorough-cut through the center of the property and across its full width. At the far end of this thorough-cut the shovel cuts in opposite directions, but by first making a number of short cuts a continuous face is produced as shown.

Figure 7 shows another method of corner opening. From one corner a through cut is made along one property line, the overburden being thrown inward and away from the property line. When the opposite boundary is reached the shovel makes alternate short and long cuts in order that it may be kept working along a line 45° to the boundary, dumping being toward the boundary line. Another thorough-cut is made along the boundary at right angles to the first and a similar procedure followed, thus giving a fan-shaped area and insuring that spoil banks are left against each property line to protect them from caving.

The thin layer of dirt left on the coal by the shovel is removed with hand shovels and brooms and vertical holes are then drilled in the coal by hand augers or power drills at intervals of about 6 ft. and a few feet back from the face. The Jackhamer drill with a dull drill bit is used in the Danville field. The Clipper Blast Hole drill is also used for this purpose. Wet holes are dried out by firing one-fourth of a stick of dynamite in the hole. The coal is shot by using about a quart of black powder in each hole, and a keg of powder gives about 110 tons of loose coal in the Kansas field.

At small operations the coal is still shoveled into pit cars by hand, but small revolving steam shovels are rapidly replacing hand labor for loading wherever conditions permit their use.

Width of Road Bed on High Embankment.—The recently issued supplement to the Manual of the American Railway Engineering Association contains the following adopted recommendations for the advisable width for newly-constructed roadbed on high embankments of 50 ft. or more by dumping from the trestle (no allowance to be made in height):

Anticipated shrinkage 7 per cent, add 10 per cent of height to each shoulder.

Anticipated shrinkage 10 per cent, add 15 per cent of height to each shoulder.

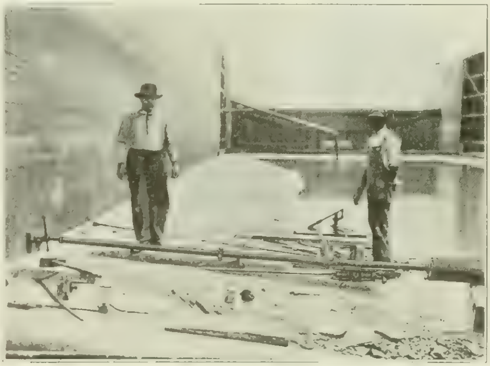
Anticipated shrinkage 15 per cent, add 22.5 per cent. of height to each shoulder.

Method of Drilling 12 ft. to 17 ft. Holes in Concrete Lock Walls

In order to strengthen the lock walls at Lock and Dam No. 1 on the Brazos River at Navasota, Tex., flat holes, 12 ft. to 17 ft. in depth, were drilled through the concrete and rods placed to tie the walls together. The work is described in the August Mine and Quarry from which the following note is taken:

The lock and dam were built as a part of the government enterprise of making this stream navigable for vessels of light draft. After completion it was ascertained that the water pressure on the inside of the lock was so great as to crack the bottom of the lock, due to the loose character of the earth supporting the walls on each side. The lock is 55 ft. wide.

Sullivan rotator hammer drills, equipped with a cradle or shell mounting complete with feed screw and mounted on the arm of a 2½-in. single screw column, were used for the drilling. One end of the column was braced against the wall on which the drilling was being done, and the other end against the end of a telephone pole, which stretched across to the opposite wall of the lock.



Drill and Mounting at Brazos River Lock.

The work of drilling was accomplished very successfully, the holes being true and in line. The material encountered was concrete made of limestone rock. Forty-four holes were drilled, some to a depth of 12 ft. and some of them 17 ft. Thirty-eight of the holes were begun with a gauge of 3 in., finished at 2½ in.; six with a starting gauge of 3½ in., finished at 2¾ in. The longest length of steel employed was 20 ft. These holes were drilled at a slight angle above the horizontal, about 1 ft. in 12. Seven-eighths-inch, hollow hexagon steel was employed, using a 6-point rose bit. The drills were placed about 4 ft. back from the wall, and were operated by compressed air at 80 to 100 lb. pressure. The holes were cleaned of their cuttings at first by air only, using a hose with a small pipe long enough to reach to the bottom of the hole, and connected with the air line. Later a more satisfactory arrangement was employed; the hose being connected with a pump and a jet of water kept in the hole all the time. The drilling proceeded faster with this assistance. The 12-ft. holes were put in in about 1½ hour with the aid of the water jet and the 17-ft. holes in about 2 hours' drilling time. Two men were used with each of the two drill outfits.

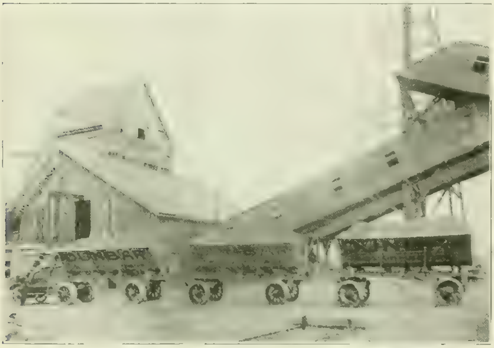
In addition to the horizontal holes above described, additional holes were drilled, starting about 3 ft.

above the lower end of the long holes at as sharp an angle as possible, and intersecting the long holes about 2 ft. inside the face of the wall. The drills were held by hand for this work. When these holes were completed they were used for grouting in the tie rods.

Two-inch wrought iron rods with turn buckles were then inserted and tightened up after the grouting had set. The work proved entirely satisfactory and the lock is again being used for its regular purpose.

Tractor-Trailer Outfit for Hauling Crushed Stone

By means of the tractor-trailer outfit illustrated below the Dunbar Stone Co., of Detroit, Mich., is stated to be able to haul 35 cu. yd. of crushed rock at a load. The outfit shown consists of a Knox tractor and Lee trailers. The first and rear trailers of the train each have a rated capacity of 10 cu. yd. and the middle one 8 cu. yds. With the load crowned up these capacities are increased to fully 12½ cu. yd. and 10 cu. yd., respectively.


Tractor-Trailer Outfit of Dunbar Stone Co.

A particularly interesting feature of this outfit is the method taken by its owner for obtaining full advantage of the advertising possibilities of his hauling equipment. Even in Detroit where motor vehicles of unusual design are common, these Dunbar trains excite a great deal of interest. Painted a bright yellow and with the word "Dunbar" in black letters 2½ ft. high, their advertising value to the company is large.

Coal Production in 1916.—Figures compiled by C. E. Lesher, of the United States Geological Survey, Department of the Interior, show that the total value at the mines of the coal produced in 1916 was $867,125,638. Bituminous coal and lignite were valued at $665,116,077, an average of $1.32 per net ton, compared with $1.13 per ton in 1915, an increase of 19 cts., or less than 17 per cent. Pennsylvania anthracite was valued at $202,009,561, an average of $2.30 per net ton, compared with $2.07 per net ton in 1915, an increase of 23 cts., or 11 per cent. The average value per net ton at the mines (exclusive of selling expense and stock shrinkage) of all anthracite shipped in 1916 of chestnut size was $3.51; of stove, $3.40; and of egg, $3.32. The average value of pea size was $2.10. The average values of the smaller sizes ranged from 67 cts. per net ton for "boiler" to $1.31 for buckwheat No. 1.

Railway Practice in Steam Shovel Operation

At the last annual convention of the American Railway Engineering Association in March, 1917, the Committee on Roadway submitted a report dealing with the various classes of excavating equipment and their uses on railway work. Certain recommendations of the committee were adopted and have been published in the July Bulletin as a supplement of the 1915 edition of the Manual of the association. The following matter is abstracted from the above-mentioned bulletin:

The general requirements for steam shovels are either so standard as to require no particular explanation or so very special as to make generalities impossible. A standard size and type of shovel manufactured by a well-known and reliable maker in a general way carries in itself ample guarantee, both in regard to its proper design and in respect to the quality of materials and workmanship entering into its construction. Certain special features, however, are noted that should be carefully borne in mind when purchasing this equipment.

Size.—The size of shovel used for any work must be decided by the character and quantity of excavation and the local conditions. In general, the commonest sizes are 60 to 80-ton shovels for the usual railway work. The following gradient of sizes may, however, be of service: For light grading, up to 25,000 cu. yd. per mile, where a shovel can be used economically, a light revolving shovel is to be desired. For 25,000 to 40,000 cu. yd. per mile, a shovel of 50 tons is a good size. For 40,000 to 60,000 cu. yd. per mile, a shovel of 60 to 80 tons is well suited. For anything over 60,000 cu. yd. per mile, the shovel may run up to well over 100 tons economically if its transportation is not too expensive, and if the ground is fit to carry the weight on sub-grade during excavation.

Delays in Steam Shovel Operation.—The greatest cause of delay in steam-shovel work is in the removal of the excavated material. Too great care and attention cannot be given to securing proper and ample equipment in the matter of cars and locomotives, and in the proper systematization of service, track, transportation and disposal. The economic success of a steam shovel depends, above everything else, on having an empty car always ready to replace a loaded one under the dipper. Too great stress cannot be laid on this point. Careful management, through organization and unceasing superintendence and foresight only, however, can accomplish satisfactory results even with a thoroughly-equipped plant.

As the plant charge against steam-shovel work is always an important item, especially where the haul is long, requiring a large equipment in cars and locomotives, continuous operation is desirable. For this reason, either three 8-hour shifts or two 10-hour shifts are recommended. Where the service is not too trying on the machinery, three 8-hour shifts are more economical, if they do not upset other parts of the organization. When, however, the work is severe, two 10-hour shifts are preferable, as this arrangement gives two hours between each shift for repairs and overhaul in the plant. For night work, where electricity is not available, a small turbo-generator set, similar to that used on a locomotive, can be set up on the shovel for lighting the immediate works.

An old locomotive tender is a very valuable adjunct to a steam shovel, especially where delays may be caused from irregularity in coal and water supply.

The greatest cause of stoppage in the shovel proper is due to carelessness or incompetence in the operator. He should see that his engine-room and all moving parts are kept thoroughly cleaned and accessible. He should train his pit gang to watch the under-gearing and track. He must see that his boiler is washed out as often as necessary, depending on the water used, and that his flues, heads and sheets are tight and in repair. He must continually inspect all parts liable to wear or extraordinary strain and make renewals before the accident occurs. He must have a light and accurate hand on the propelling lever and must judge his load on the hoisting chain or cable, especially in an over-powered shovel. Heavy breakage in hoisting chains in such a case is almost always due to an unskilled or careless operator. The mechanical delays on a good shovel operated by a good runner are almost negligible.

A good works superintendent or master mechanic can develop good shovel runners if he has time and patience. This, of course, is often difficult on railway work, especially in the Maintenance of Way operations. With average runners, the commonest repairs are as follows:

Hoisting cables.
Hoisting chains.
Swinging cable.
Teeth and tooth bases.
Friction bands and blocks.
"U" bolts or double bolts and yoke.
Pinions (especially shipper shaft).
Dipper latch and hinges.
Dipper stick (in hard digging).
Sheaves and pins (especially at end of boom and padlock block).
Shipper shaft.
Crankshaft on boom engine.
Eccentric straps.
Bearings.
Arm jacks.
Rack bolts.
Clevis strap between dipper and bail.
Ordinary engine repairs.
Ordinary boiler repairs.
Ordinary pipe fittings.

In the above list of most common repairs much of the trouble is undoubtedly due to lack of proper inspection and judgment in removing worn parts before they actually break, also to careless handling of the shovel when unusual strains arise in heavy digging. Where a good runner is secured the repairs will be very small. Where the work is near a base of supplies, the stock parts carried may be very small. There are also many repairs that may be made by the job blacksmith without special stock.

Repair parts to be stocked for emergencies when shovel is built as recommended, are as follows:

6 cold shuts for hoisting chain.
3 cold shuts for propelling chain.
1 swinging cable.
1 cable sheave and pin.
1 chain sheave and pin.
1 set teeth.
1 tooth base.
1 clevis strap connecting bail and dipper.
2 bolts for yoke block, or 2 "U" bolts.
1 set friction blocks.
1 pair each size, bronze bushings.
babbitt, if used anywhere.
1 set piston rings.
6 water glasses.
Miscellaneous assortment of packing.
Miscellaneous assortment of bolts.
Miscellaneous assortment of pipe and fittings.

The following list of tools is generally recommended. The assortment is very complete and may be reduced at discretion, depending on the proximity of other ready means of supply and repairs:

100-lb. anvil.
1 Axe, chopping, 4½-in
1 Bar, buggy, 3-ft.
1 Bar, claw.
6 Bars, lining.
1 Bar, slice, fire, 5-ft.
1 Set blacksmith tools.
2 Blocks, snatch, 6-in.
Set of bolt taps and dies, with holders.
1 Brush, chain, long handle.
2 Buckets, G. I., 2-gal.
1 Cable, ⅝-in., 60 ft. long.
1 Can, oil supply, 1-gal. (kerosene).
3 Carriers, timber.
6 Chisels (two flat, two round, two cape).
2 Containers, oil, 5-gal.
1 Cooler, water, 8-gal.
2 Cups, drinking, enamel.
1 Cutter, pipe.
1 Cutter, gage glass.
Set of twist drills.
1 Flue cleaner.
Forge, blacksmith, portable (with coal).
1 Gage, track.
1 Pair frogs, rerailing.
Set of taps and dies, with holders.
1 Hacksaw, adjustable, 8-in. to 12-in.
2 Hammers, B. P., 1½ to 2 lb.
6 Hammers, sledge, double-face, 8-lb.
1 Hammer, sledge, double-face, 16-lb.
1 Hoe, fire, 5-ft.
50 ft. hose, canvas, 1¼-in.
2 Jacks, ball-bearing (size dependent on shovel).
1 Lantern, hand.
2 Oilers, long spout.
3 Padlocks.
2 Picks, clay.
1 Pot, tallow.
1 Rake, fire, 5-ft.
1 Ratchet, drill.
1 Saw, crosscut (two-man), 5-ft.
1 Saw, hand, crosscut, 26-in.
1 Screwdriver, 12-in.
6 Shovels, round point, short handle, No. 2.
1 Shovel, scoop, No. 3
1 Vise, combination, pipe and bench.
4 Wrenches, monkey, 6-in., 8-in., 12-in. and 18-in.
4 Wrenches, Stillson, 6-in., 18-in., 24-in. and 36-in.
1 Set wrenches, single-end, ½-in. to 2½-in.

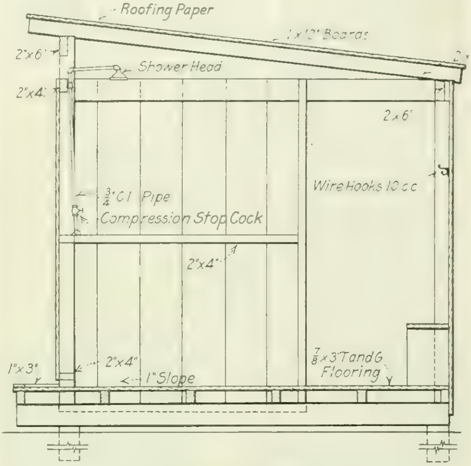
Locomotives.—The type and size of locomotives used on steam-shovel work must depend on the character of the work, weight of trains, the length of haul and the local conditions. On maintenance work, ordinary road engines are usually well suited, especially if an ample tail track is provided in the pit that too much shunting is not required. On construction, where the track is apt to be bad and curves abrupt, the 4 or 6-wheeled saddle-tank type is preferable, at least near the shovel. If the haul is long and the track is fair, heavier locomotives should be used in transportation.

In general, on construction where the tracks are inclined to be rough and curves sharp, the shorter the wheel base on a locomotive the better, within limits. Where road engines, or even heavy switch engines, are used, there is always danger of derailments and frame breakage. Where "dinkeys" are used, it is well to pay special attention to springs, brakes and the location of the center of gravity with reference to the wheel base. Some makes are so balanced that under heavy loads and on steep grades, two wheels are sometimes lifted clear off the track, with the natural resulting delays, if not damage.

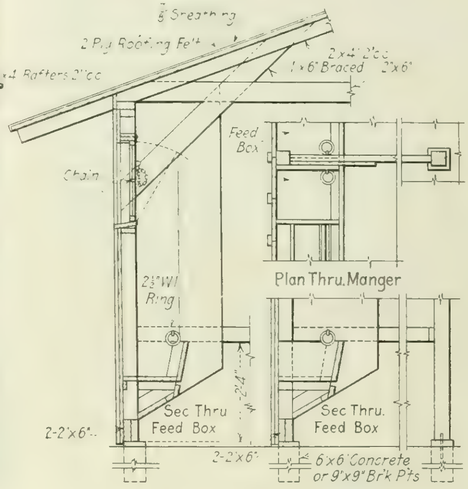
Track.—The shovel track should be made up of 6-ft. sections, with strap connections. Bridles of ½-in. by 2-in. iron should be used, with wedge grips. A notched tie should be used as a check, behind the front trucks, supported by steel saddle clamps attached to the rail with wedged grips. Similar clamps should be placed before the front wheel without tie check. Nothing less than 60-lb. rail should be used under a shovel, and heavier rail should be used under the larger models. No spikes are used.

On the muck track in tunnels standard-length rails are used, spiked to the ties. Where no tail track is possible and the excavation is at a breast, drive rails are very useful. These consist of half-length rails laid on their sides, with the ball of the rail against the inside of the web of the last rail spiked down. As the breast is cleared away, these short rails are driven ahead and the cars are run out on the balls of the capsized rails. When a half-length is thus driven out, it is turned right side up and spiked lightly in position and the other half-length driven out in a similar manner.

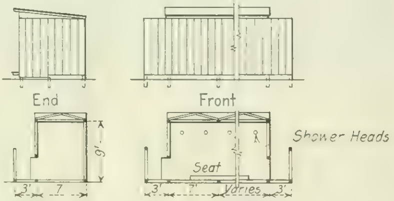
Some Details of Government Cantonment Structures That Might Be Adaptable to Construction Camps



Section Thru. Bath House



Details of Closed Stable

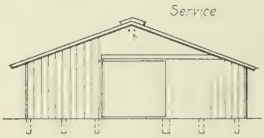


End

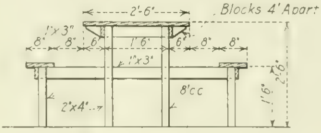
Front

Plans

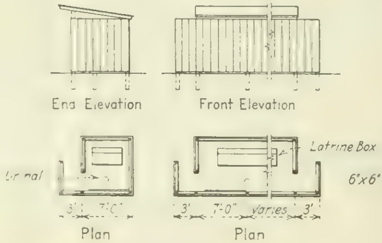
Bath House



End Elevation of Closed Stable



Detail of Mess Tables & Seats



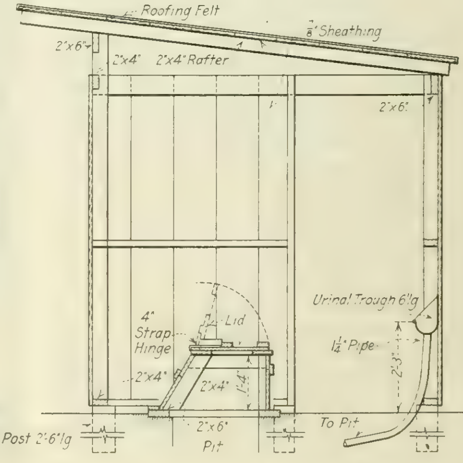
End Elevation

Front Elevation

Plan

Plan

Latrines



Section Thru Enclosure-Latrine Box & Urinal Trough

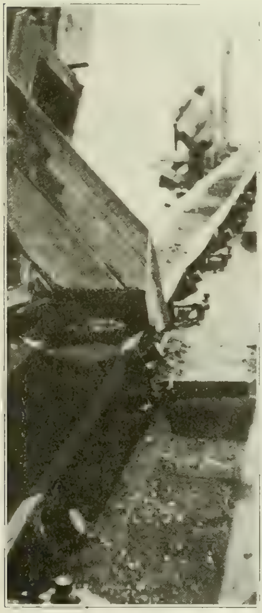
Drag Line Cableway Excavator and Washery Operated as Independent Units.

To design a plant which can be easily expanded to meet the demands of a larger market is often an important consideration for the sand and gravel producer.

The Northern Indiana Sand & Gravel Co., Wolcottville, Ind., has achieved the desired result by re-setting its dragline cableway excavator some 200 ft. from the washery and erecting a "flowing" storage bin and belt conveyors to handle the material from the excavator to the washing and screening plant. With this system, the washery and the excavator are practically two different units, either of which can run for some time after the other has stopped, whereas in the case of the general type of dragline cableway plant with the excavator discharging directly to the screens, any stoppage either of screens or excavator ties up everything.

Plant of Northern Indiana Sand & Gravel Co.

The capacity of the screens is several times the present output of the plant and when the car supply and market condition warrants, a second cableway excavator can be added or a dragline or steam shovel installed without much change in the general layout.



Gate and Spout Arrangement.

As it is, the plant is producing as high as 22 cars per day with a Sauerman 1½-yd. dragline cableway excavator, operated by a 10x12 Lidgerwood two-drum hoist, doing the digging. The excavator which formerly conveyed the gravel directly to the screens, now dumps into a bin which has a "flowing" capacity of about 140 cu. yd. A "home-made" gate and spout arrangement feeds an almost uniform stream of material from this bin onto a 24-in. conveyer belt, 65 ft. long, which carries the material to a 42-in. x 10-ft. Austin revolving stone screen. This screen rejects all gravel which will not pass through a 1½-in. perforation. The rejected material drops into a No. 4 Austin gyratory crusher to be reduced and is returned on a No. 3 Austin elevator to the stone screen. This is a closed circuit and no material can pass on until reduced to a 1½-in. size. All material passing through the stone screen falls on a second 24-in. conveyor belt 120 ft. long and is carried to the top of the plant.

On the plant there are two batteries of three Dull inclined conical screens. The gravel is graded in these screens and the sand from the screens is passed over a flat screen, making two sizes of sand. The sand then goes to two Dull sand separators where the water and dirt is taken off through overflow to the wasteway. Water for screens and separators is furnished by a 6-in. American centrifugal pump, belt driven, capacity 1,000 gals. per minute. A 100-H.P. slide valve engine operates screens and pump. Sand and gravel are retained in bins and spouted into cars. The cars are "spotted" by the railroad company and then dropped down as needed by the gravel plant crew, the loading tracks past the washery having a grade sufficient to move the cars entirely by gravity.

The general layout was designed by the Raymond W. Dull Co., and arranged by Mr. H. M. Cooper, secretary and treasurer of the Northern Indiana Sand & Gravel Co., to suit local conditions. Employes of the company, under Mr. Cooper's supervision, erected the plant.

Method of Setting Supporting Insulators for Steel Radio Towers

A novel method was adopted for setting porcelain insulators under the two 400 ft. steel radio towers erected recently at the naval torpedo station, Keypost, Wash. The method is discussed by Mr. G. A. Duncan, civil engineer, U. S. navy, in Bulletin No. 27 of the U. S. Bureau of Yards and Docks.

The first set of insulators placed were wedged up with hardwood (oak) wedges, but it was found that in order to remove them after grout was poured, a considerable area of bearing grout had to be disturbed. The remainder of the insulators were set as follows:

Three ¾-in. bolts were used as miniature jacks under each insulator. Before placing the bolts the nuts were adjusted so as to leave about ¼-in clearance between threaded end of bolt and bearing plate.

Grout was then poured, using a rather wet mixture so that when puddled it would furnish a good bed for the insulators. After the grout had set four or five hours, pockets were dug around the bolts large enough to get a wrench on the nuts.

Twelve hours after the grout was poured the bolts were taken out and pockets filled with grout. The large oak wedges carrying the weight of tower were then backed out about ½ in., which permitted the bearing plate to settle into the grout about 1/16 in.

The large carrying wedges were not taken out until the tower was completed, riveted, and all insulators set.

A large Louisiana fishing company has cut down its fuel bill more than $300 a month by installing in an oyster boat a gas-producer plant which transforms coal into power gas. This gas is being burned in an explosive engine instead of gasoline.

Government Cantonments Practically Completed on Sept. 1

The status of construction at the various cantonments on Sept. 5 is outlined in a recent statement of Col. I. W. Littell, who is in charge of the work for the government.

Of the 16 military cities for housing the 687,000 citizen soldiers selected for service by the draft, seven were ready on Sept. 5 to receive their entire quota of officers and enlisted men. These seven included Camp Taylor at Louisville, Ky.; Camp Travis at Fort Sam Houston, Tex.; Camp Lee at Petersburg, Va.; Camp Lewis at American Lake, Wash.; Camp Sherman at Chillicothe, O.; Camp Devens at Ayer, Mass.; and Camp Grant at Rockford, Ill. Seven other cantonments were ready to receive all the officers and two-thirds or more of their entire quota of enlisted men. These comprise Camp Dodge at Des Moines, Ia.; Camp Funston at Fort Riley, Kan.; Camp Custer at Battle Creek, Mich.; Camp Pike at Little Rock, Ark.; Camp Dix at Wrightstown, N. J.; Camp Jackson at Columbia, S. C.; Camp Gordon at Atlanta, Ga. The two remaining National Army cantonments—Camp Upton at Yaphank, L. I., and Camp Meade at Admiral, Md.—had already received and were taking care of more than their full quota of officers and were ready to receive the number of enlisted men originally ordered there on Sept. 5.

Approximately 150,000 men were employed up to Sept. 1 in the construction of the cantonments; since that date the force has geen gradually reduced.

A typical layout such as is required for accommodating the officers and men at a cantonment comprises, in round numbers, 1,500 separate buildings, requiring approximately 30,000,000 ft. B. M. of lumber. Each cantonment requires a complete system of water supply and sewage disposal, the piping alone for which amounts to more than 50 miles. The general warehouses, with necessary trackage, have also been provided. Where the facilities are not available in nearby cities, complete refrigerating and laundry plants have been built.

At each cantonment up to Sept. 1 it has been necessary to complete on an average of one building per hour, or for all the cantonments an average of one building every four minutes.

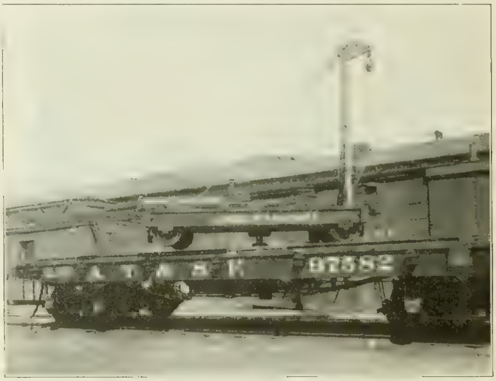
The cantonments in the east have been handicapped by the fact that it has been impossible to secure sites without going away from the railroad lines and labor markets.

Every National Army cantonment has required the building and installation of a transmission line for electrical current. At camp Upton it has been necessary to take electrical power from Northport, on the north shore of Long Island, a distance of nearly 30 miles. In addition to this, the transmission line has been strengthened all the way back to Brooklyn in order that proper service can be given. In order to furnish the necessary railroad facilities, the Long Island R. R. has been required to take up rails from sidings to build the spur-tracks required at the cantonment.

To bring the construction materials to Camp Meade, which is some distance from an electric and not on any steam railroad, it was necessary to rebuild the electric railroad to make it of sufficient strength for steam transportation. In addition, the Pennsylvania R. R. built a spur several miles in length into the cantonment site. The government had to condemn a right-of-way.

Rail Loading Device

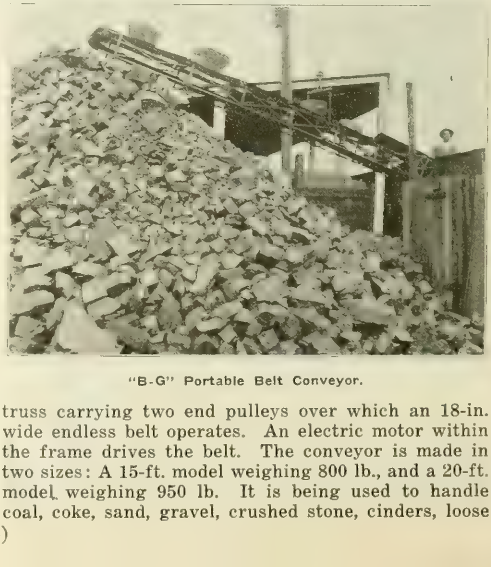
The arrangement shown in the accompanying illustration enables the Santa Fe System to load 90 85-lb. rails in 30 minutes with a labor force of three laborers and an air man on the car and three men on the ground. The most interesting feature of the outfit is the device for raising the rail loader on the flat car. By means of this the loader can be turned completely around and thus can load at either end of the flat car. The raising device consists of a piston actuated by compressed air supplied from a storage tank beneath the flat car. This arrangement was devised by Mr. Wm. Barnes, Supervisor of Work Equipment Eastern Grand Division of the Santa Fe System, and has just been placed in service on that road.



Rail Loading Device of Santa Fe System.

Portable Belt Unloader

A labor-saving machine designed primarily for unloading open cars and box cars and for short distance conveying has been placed on the market recently by the Barber-Greene Co., Gale St., Aurora, Ill. The device consists essentially of a rigidly braced steel truss carrying two end pulleys over which an 18-in. wide endless belt operates. An electric motor within the frame drives the belt. The conveyor is made in two sizes: A 15-ft. model weighing 800 lb., and a 20-ft. model weighing 950 lb. It is being used to handle coal, coke, sand, gravel, crushed stone, cinders, loose



"B-G" Portable Belt Conveyor.

brick and bags of cement. When uniformly loaded to capacity from a spout, it is claimed, that the conveyor can handle 35 tons of coal per hour or 75 tons of sand or gravel.

Limits for Lifting Track and Trestling in Making Embankment with Trains

In the recently issued supplement to the Manual of the American Railway Engineering Association the following suggestions are given regarding the construction of embankment:

It is impossible to establish set rules regarding the point where lifting track should stop and trestling begin when making embankments with trains. The character of the material is of great importance in the matter of cost. Some engineers consider that it is practically always preferable to trestle or block up the tracks without regard to the depth of fill, while others say it is advisable to raise the track as the fill progresses, up to 25 ft. or more. On the average, from 6 to 10 ft. are the commonest limits. With, however, the great fluctuation in the costs of both labor and materials, it is recommended that each case be treated as an individual problem. The cost of raising should be carefully figured, including the delays and interference caused to and by traffic where such exists, and this set against the cost of trestling, including labor and materials. It should be remembered that in some cases a "run-around" can be formed very cheaply, while in other places this requires either an auxiliary fill or trestle.

In estimating trestle for fills over which regular traffic is not to pass, the length of haul is important. Where the haul is less than two miles, light side-dumping cars may be used, and a very light trestle is required.

Of course, the geographical location of such work also has an important influence on this question, as climate, character and availability to fill materials, labor, lumber and other supplies vary enormously with different sections of the country.

Each engineer, familiar with his own section and the local conditions surrounding the work, is the man to estimate the relative cost and decide where raising track should stop and trestling should commence, either on new locations or under existing track and traffic.

Allowance for Shrinkage in Fill

The recently issued supplement to the Manual of the American Railway Engineering Association contains the following conclusions adopted at the 1917 convention, regarding the allowance for shrinkage:

In determining the allowance for shrinkage to be made in a fill, it should be remembered primarily that it is easier to add to the height of a fill that settles than to lower the track if the settlement does not amount to as much as that anticipated in the original allowance. Therefore, unless the shrinkage of a material is well known in the conditions under which the fill is made, it is best to be well on the safe side; i. e., little or no allowance should be made in height; the extra material, when possible, being deposited where it will be conveniently available for raising the track, as required. The allowance in width should be about 5 per cent to 20 per cent of the height of the fill, depending on the material and conditions.

The material used for fill varies in shrinkage from sound, non-disintegrating rock, or gravel, which is least, to certain swelling clays, which give the greatest shrinkage both in compactibility and erosion at the slopes. While vegetable loam has a large percentage of actual shrinkage, it so quickly produces a protection cover of vegetation that the shrinkage due to erosion is usually small. Where frozen material must be used in making a fill, heavy settlement must be expected, and this is to be avoided where possible.

The material and contour of the gound supporting the fill is also a matter of considerable importance. This is especially so where unstable material is encountered.

The method of making the fill should also be carefully considered. When the tracks are being raised under traffic, the vertical shrinkage will be largely taken care of in the course of the work. When the fill is made by teams or such means as to reasonably tamp and compact the fill in thin layers as it is made, the same is true. Where, however, the fill is made by trestle and without puddling or other method of compacting, the settlement is apt to be considerable.

Concreting Plant Mounted on Skids for Building River Wall

A compact mixing and placing plant is being used in the construction of a concrete retaining wall on the Menominee River front at Milwaukee, Wis. The concreting outfit is mounted on skids supported on pipe rollers so that it can be moved along the bank as the work progresses. The wall is 735 ft. long, and has a top width of 2 ft. 3 in., a base width of 4 ft., 9 in., and a height of 6 ft., 3 in. It is located about 30 ft. from the shore line and contains 25 cu. ft. of concrete per lineal foot. The plant consists of a 10-ft. Chain Belt mixer, an elevating and spouting system and a 10-HP. Byers engine. The latter operates the elevator, and also is used to move the outfit. In making a move the cable is disconnected from the skip bucket and attached to a dead man or post. The engineer then pulls the outfit ahead. Approximately 40 ft. of sea wall is constructed before the outfit is moved ahead. The concrete materials are distributed on the shore along the line of the work. Ten men are employed at the mixer, and 2 men at the forms. The work is being carried out by the Michie Construction Co., of which W. L. Stimple is superintendent.

Movable Concrete Plant Spouting Concrete Into River Wall.

News Letter

St. Louis Items.

J. T. Collins, Mt. Vernon, Ill., wants to let contract for driving 800 ft. of piling.

William Wallace writes us from Lockridge, Ia., that he has four teams idle at that place.

P. J. Murphy, Moberly, Mo., reports that he has covered all of his bridge filling jobs on the Wabash R. R.

Dudley Smith and Harrington Bros. have their team outfits at work at Benton, Ill. Both jobs getting along fine.

A. A. Luck, 524 Rialto Bldg., Kansas City, Mo., reports that he has a machine outfit idle. The balance of his outfit is idle.

Blythe Bros. have their team outfit at work near Consol, Ia., on a piece of work that they subbed from Thomas L. Rosser, Jr.

M. C. Connors & Co., 610 W. Madison St., Chicago, Ill., has 30,000 yd. of nice machine work on the C. B. & Q. R. R. at Peoria, Ill., to sublet.

D. A. Daley, the hustling representative of the Walsh Construction Co., is getting things lined up rapidly on their I. C. railroad work in Kentucky.

Allhand-Hedges Construction Co., 527 Kentucky Ave., Joplin, Mo., have about 9,000 yds. of bridge filling on the Frisco R. R. near Continental, Mo., to sublet.

Smith & Hannan have finished their work on the Wabash R. R. at Decatur, Ill., and moved this shovel outfit on to their Illinois Central work in Kentucky.

Thomas L. Rosser Jr. is moving a four yard steam shovel outfit from Earlham, La., on to a piece of Smith & Hannan's work on the I. C. R. R. in Kentucky.

Peter McVeigh of McVeigh & Poupore Co. stopped off here on his way south to take a bunch of rock men with him to their new Kentucky work on the I. C. R. R.

P. J. Hannan & Co. have about 11,000 yds. of team work to let near Forrest, Ill. Free transportation for outfits and labor over Wabash R. R. Write them—Boatman's Bank Bldg., St. Louis.

The North Fork Drainage District No. 2 of Jasper County, Ill., has a ditching job that will amount to about $6,000 to let. Contractors interested in this write C. A. Prather, secretary, Newton, Ill.

James T. McMahon of the McMahon Contracting Co. took a run down to Kentucky to look over a part of Smith & Hannan's team work on the Illinois Central R. R. When we saw McMahon last he was figuring pretty hard on taking quite a slice of this.

Koenig's labor agency, St. Louis, shipped six car loads of laborers to both coasts last week, two car loads going to Boston, Mass., and four car loads to southern California. The labor market has been easier here the past month than it has been at any time this summer.

Montgomery & McCabe are going to do the tracklaying, bridging, ballasting and surfacing on Meany's work on the Santa Fe R. R. in Kansas and Oklahoma. Frank McCabe passed through St. Louis the other day on his way to Caney, Kan., to open an office there and begin work.

The Board of Public Service, St. Louis, awarded to Herklotz and Henschert for $64.495.68 a contract for construction of a viaduct through Bellerive Park, along Kingshighway, opening the highway from Riverview Park on the south to O'Fallon Park on the north. The viaduct, the last to be built in completing the boulevard, will be ready within a year.

For the first time in history, a civilian is in official charge of the St. Louis River and Harbor Improvement District. The civilian is W. S. Mitchell, a civil engineer, whose appointment as assistant engineer in charge of the district was made by the War Department this week. He has assumed his new duties. Until 1911 the employment of civilians for any such work was prohibited by law. At that time, however, an amendment to the River and Harbor bill provided that others than military officers might serve. Mitchell's appointment is the first time the privilege has been exercised here. Mitchell took the post after the withdrawal of Lieut. Col. Clark S. Smith, who went recently to Rockford, Ill., to assist in training the new National Army. Lieut. Col. Smith had been in charge since the departure of Col. McD. Townsend with the Twelfth Regiment Engineers, for France, several weeks ago. Mitchell is a graduate of the University of Virginia. For thirty years he has been widely known as one of the best of the company's engineers. The St. Louis River and Harbor Improvement District extends from St. Louis to Memphis, and from St. Louis to Davenport, Ia. It was formed many years ago.

Officials of the Rock Island R. R. notified President Kinsey of the Board of Public Service that their company will pay one-third the cost of eliminating grade crossings between a point east of Union avenue in Forest Park and the city limits of its own line and the Wabash as far northwest as the city limits. The Board of Public Service has estimated that it will require $1,600,000 to depress the Wabash tracks and remove the Rock Island tracks west of DeBaliviere Ave. Part of the expense of the elimination will be the purchase of the Rock Island's right of way from DeBaliviere Ave. to the city limits. The strip will be sold to the city, Rock Island officials announce, for $79,260. The Rock Island used the Wabash tracks from DeBaliviere Ave. to Twenty-third St. After abandoning its own rails west of DeBaliviere Ave. the Rock Island will connect with the Wabash in the county, near the Page Ave. station. The Wabash agreed tentatively some time ago to the plan for depressing its tracks and elevating the streets, provided the Rock Island would share the expense. President Kinsey says he will inform Wabash officials of the Rock Island's concurrence in the division of the expense and of its willingness to remove its tracks. The city will pay about $500,000 as its share of the improvement, and will have the Rock Island right of way for development as a boulevard into the county. The plan contemplates the elimination of all present grade crossings on the Wabash between Union Ave. and the city limits, including that at Delmar Blvd. Provision will be made for the extension of streets westward in the fture in addition to those already established. President Kinsey says he hopes to obtain the final approval of the Wabash in time to permit the introduction of an ordinance in the Board of Aldermen on September 21, when it reconvenes after the summer vacation.

A. B. KOENIG.

Personals

W. F. Tanquay has been appointed secretary of the County Highway Commission of Sacramento County, California.

C. J. Erickson of the Erickson Construction Co., Seattle, Wash., has organized the Erickson Engineering Co., with a capital stock of $2,000,000 and will engage in shipbuilding.

H. Walter Leavitt, formerly student assistant testing engineer for the U. S. Office of Public Roads, has been appointed testing engineer for the State Highway Commission of Maine.

Joseph W. Richardson has opened an office at 11 Broadway, New York City, where he will engage in a general marine engineering practice, specializing in marine survey work, the repair of vessels, the design and construction of shipbuilding plants and the design and construction of mechanical equipment for both vessels and plants.

James A. Short of Chicago has been re-elected president of the Illinois Building Trades Council. C. A. Townsend of Aurora was elected first vice president; S. H. Briggs, Chicago, second vice president; Charles Bush, Dixon, third vice president; Edward Smythe, Peoria, fourth vice president; J. A. Harding, Champaign, fifth vice president, and D. H. Richmond, Aurora, secretary-treasurer.

J. E. Gibson, at present principal assistant engineer with the American Pipe & Construction Co. of Philadelphia, has been elected manager of the water works at Charleston, S. C., and will take over his duties when the property of the Charleston Light & Water Co. is transferred to the city. Mr. Gibson is a graduate of the University of Arkansas in the mechanical engineering class of '94. From 1895 to 1896 he was assistant engineer with Jay M. Whitham, consulting steam and hydraulic engineer of Philadelphia. From 1896 to 1897 he was with the Moro Phillips Chemical Co. (now the General Chemical Co.) of Camden, N. J., as mechanical engineer of power plant and construction. From 1897 to 1898 he was superintendent and engineer of the Waukesha Water Works Co., owned and operated by the American Pipe & Construction Co., and afterward purchased by the city of Waukesha, Wis. For the past nineteen years he has been with the American Pipe & Construction Co.

John W. Alvord, C. E., of the firm of Alvord & Burdick, consulting engineers, Chicago, has been appointed by Governor Lowden of Illinois as a member of the Illinois State Board of Natural Resources and Conservation. Other members of the board are: Geology, Prof. Thomas C. Chamberlain; biology, Prof. John M. Coulter (both of the University of Chicago); chemistry, Prof. William A. Noyes; forestry, Prof. William Trelease (both of the University of Illinois). Mr. Alvord is to advise on water resources. President Edmund J. James of the University of Illinois is ex-officio member and chairman of the board. The board is appointed under the new Civil Administrative Act, and is expected to study the resources of the state, the work of its departments under the lines indicated, and advise the governor and the legislature from time to time on matters in which the welfare of the state may be promoted. The members of the board serve without compensation.

H. E. Hilts, formerly district engineer at San Francisco for the Portland Cement Association, has been elected by the board of directors of that body to succeed the late Mr. J. P. Beck as general manager. Mr. Hilts was born in New York and obtained his technical and engineering education at the University of Pennsylvania. His first work was as rodman with the Mexican International Railroad. Later he was in the employ of the Philadelphia and Western Railroad. For two years he was instructor in the engineering department of the University of Pennsylvania, after which he entered the service of the New York Central Railroad, leaving that company to become associated with the Portland Cement Association as road engineer in 1913, for territory comprising the New England and Northeastern States, having been stationed at Albany and Easton, Pa. In 1915 he was appointed district engineer at San Francisco. Mr. Hilts is an associate member of the American Society of Civil Engineers, member of American Society for Testing Materials, associate member of the American Railway Engineering Association and member of the American Concrete Institute.

Industrial Notes

The Bates Valve Bag Co. is now located at its new offices at 7310-20 South Chicago avenue, Chicago, Ill.

The Warren Webster & Co., Camden, N. J., has moved its Detroit branch office to new and enlarged offices at 2123 Dime Bank Bldg., Detroit, Mich. A. B. Knight is manager for the Detroit district.

Samuel Swett, 149 Broadway, New York City, has been appointed exclusive agent in the United States for George Craddock & Co., Ltd., Wakefield, England, manufacturers of wire rope, cable, etc.

Chester H. Lehman, for the past six years secretary and director of the Blaw-Knox Co., Pittsburgh, has entered the service of the United States Government for the duration of the war as first lieutenant in the Ordnance Department. Mr. Lehman is a Harvard graduate, class of 1909.

The Duplex Truck Co., Lansing, Mich., is constructing new factory buildings that will give about 100.000 ft. of additional space. One of the buildings will be 402 by 72 ft. and the other 306 by 72 ft. Both are two-story structures. With the completion of the buildings the company's production of heavy haulage trucks will be increased to about 300 monthly during 1918. It is stated that the value of Duplex trucks to be manufactured during 1918 will total $12,960,000, or about ten times the value of the 1917 production.

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The Successful Swinging of the Quebec Bridge

Civil engineers and contractors will rejoice at the news of the successful raising of the great center span of the Quebec Bridge. A work unprecedented in magnitude and unique in difficulty has been finally completed, after two disasters, the first in 1907, when the bridge collapsed during erection, and the second a year ago, when the center span fell while being raised from scows (see Engineering and Contracting, Sept. 27, 1916).

Elsewhere we publish a newspaper description of the process of raising the new span, which was begun Sept. 17 and finished Sept. 20. Many of our readers will find this non-technical "story" of interest, not only because of its vividness, but because of the evidently great impression that this engineering achievement produced in the mind of the "lay" writer who describes it.

Growing Popularity of Fee Contracts for Building Construction

If the engineer or architect receives a percentage fee for the design of a building, why should not the building contractor also be compensated with a fee? Probably the main reason why fee contracts are not more extensively used is to be found in the fear of the owner that the building will cost more than the estimated sum, for a fee contract ordinarily guarantees no definite total cost. Nevertheless the fee contract grows steadily in popularity.

In our issue of Aug. 22 the officials of three large construction companies were quoted as to methods employed by them in selling the services of their companies. Each of them secures a great deal of work under some form of "cost plus a fee contract." Among the reasons advanced in favor of such a contract are these: (1) The contractor can win continued success only by satisfying his clients, for it is upon their recommendations that he mainly depends in securing new work. (2) The interests of the owner and the contractor are not opposed one to the other, but are mutual. Changes can be made in plans without incurring bills for "extras," litigation is avoided, and "scamping" the work is unheard of. (3) The contractor is not under the expense of estimating the probable cost in detail, and the owner need not incur the expense of continuous inspection of the work. (4) The contractor can assist the owner's engineer or architect in improving the economic design of the building. (5) The contractor wishes to earn his fee as quickly as possible, particularly if the fee is a fixed sum, so that the work is expedited.

Against these advantages the owner often sets the uncertainty as to what the building will cost; but if he can be induced to believe that the contractor is an efficient manager, experienced in the given class of work, and, above all, honorable, doubt as to the exact ultimate cost does not remain an insuperable objection.

In these times of uncertainty as to delivery of materials and as to the labor market, cost plus a fee contractors are becoming increasingly popular.

How Condensation of Atmospheric Moisture Causes Rot and Rust

In designing and building walls and roofs there has frequently been a failure to consider the effect of atmospheric humidity. Air always contains water which will condense upon any solid whose temperature is below the "dew point" of the air. Hence, if the warm air inside of a building escapes through pores or cracks, it will give up some of its moisture to the cooler surfaces with which it comes in contact.

In our last Buildings and Structures Monthly issue (Aug. 22) there was an article entitled "Relative Effectiveness of Various Types of Roofs in Preventing Condensation," in which the authors pointed out that it is impracticable to prevent the condensation of atmospheric moisture on the top side of roof planks. Consequently such plank should be treated with creosote or other preservative to prevent decay. Moreover, the roof should be made thick enough to flatten the temperature gradient to such an extent that moisture will not condense on the under surface of the roof planks. The authors give data for the proper thickness under stated conditions.

In the same issue another article describes the rusting of certain steel columns in a fireproof hotel 7 years old. It is stated that the brickwork and ashlar facing did not suffice to prevent the penetration of rain water and that the steel in the outer faces of wall columns had begun to rust. While it may be true that rain had penetrated the masonry, it is not improbable that the humidity of the air may also have caused the rusting of the steel.

Structural engineers will do well to give consideration to the phenomenon of moisture condensation resulting from the drop of temperature of air that circulates even slowly in roofs or walls.

$500,000,000 for Cantonments and Other Government Buildings for War Purposes

Major W. A. Starrett, expert adviser in the building of the 16 cantonments for the draft armies, states that the government has expended $150,000,000 on this work in three months. More than 4,000 miles of finished road surface, 2,000 miles of water pipe, 2,000 miles of sewers and 4,000,000,000 ft. B. M. of lumber were involved in this work. At each of the 16 camps there were employed 8,000 to 10,000 men. On one job the contractor held a foreman's meeting every morning, at which as many as 500 foremen were present. The government had 150 representatives in each camp.

Mr. Starrett states that in addition to the gigantic cantonment construction the government has $350,000,000 worth of buildings in progress or contemplation.

The Counties of Iowa to Co-operate in Buying Bridge and Road Materials

As a result of delays in securing the delivery of materials, the supervisors of the 99 counties in Iowa have taken the first step toward co-operative buying under standard specifications. Delivery on contracts, especially on steel and lumber, has been so slow that construction work has been seriously delayed and often entirely suspended in many counties. Acting individually, the counties were almost helpless. This situation led Mr. T. H. MacDonald, Chief Engineer of the Iowa Highway Commission, to deliver a paper before the State Association of County Supervisors, outlining a co-operative buying system. The Association endorsed Mr. MacDonald's plan, and provided for the appointment of an executive committee to put it into effect.

In our next issue, Oct. 3, we will print Mr. Mac Donald's paper in full, for we believe that he has advanced a plan that will be adopted, not only in Iowa, but in many other states.

Bituminous Carpets on Plank Floors of Bridges

Probably the first use of a bituminous carpet on a plank floor of a bridge occurred in California. At any rate, for many years it has been the practice of certain county engineers in that state to cover the wooden floors of trestles and bridges with a thin layer of heavy asphaltic oil and sand, forming a mat that not only protects the plank from abrasion, but from rot.

The Minnesota Highway Commission has been experimenting with a bituminous surfacing for plank floors, and the statement has been issued that the results justify the extended use of this type of floor surfacing.

The Illinois State Highway Department for the past 4 years has been using a bituminous mastic for covering bridge floors. A general description of this work and the unit cost will be found in our issue of Aug. 1. Elsewhere in this present issue we give specifications for the work.

Graphical Solution of Continuous Beams

By W. S. WOLFE,
Instructor in Architectural Engineering, University of Illinois.

The analysis of a continuous beam of two unequal spans with an irregular loading is a rather difficult problem when analytical methods are applied. Such a problem can be handled by graphical construction in a very interesting way.

The upper part of Fig. 1 illustrates a continuous beam of two unequal spans which is assumed to carry a number of concentrated loads at irregular intervals. All three supports will be considered to have the same elevation. The concentrated loads are laid off in the force polygon, Fig. 2, and the pole p is chosen, making H equal to 30,000 lb. for convenience. Starting at m the funicular polygon m 1, 2, 3, 4..........n is drawn in Fig. 1. Now if we only knew where to locate point z, we would have the reactions and the moment diagram by drawing the closing strings zm and zn and parallel to these the corresponding rays in Fig. 2. The elastic curve is used in locating this point z.

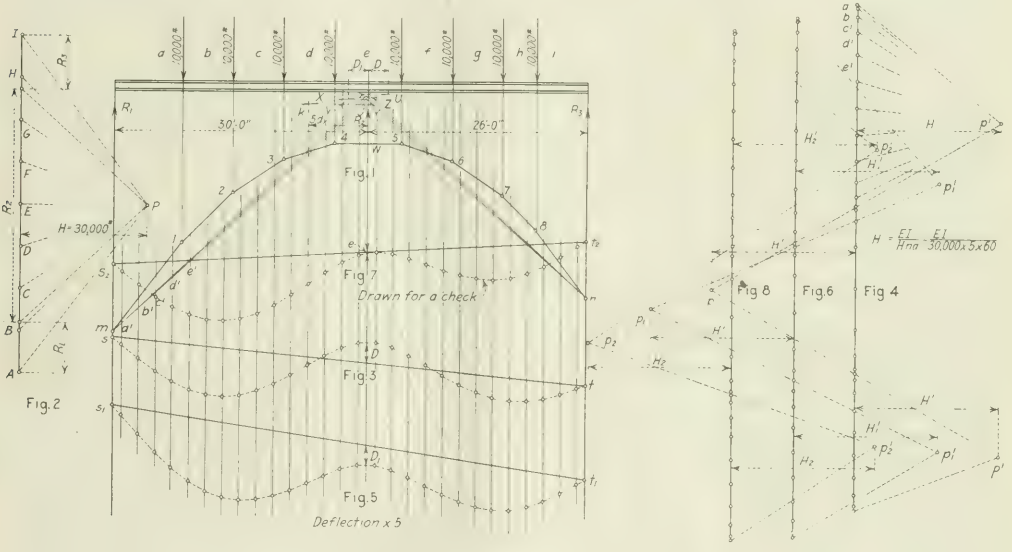
Choose some point x on the action line of R_2, which appears to be a reasonable guess for z, and draw xm and xn. For the present consider that these two strings are the closing strings of the moment diagram and draw the elastic curve using the ordinary graphical construction. This moment diagram in Fig. 1 is divided into slices and the areas of these slices are laid off to some scale along the load line in Fig. 4. The pole distance H' is made equal to $E\ I \div (Hna)$, in this case equal to $E\ I \div (H.5.60)$, so that the vertical intercepts in Fig. 3 between the funicular polygon and the closing string st will give five times the actual deflection. For positive areas the pole p' is taken on one side of the load line and for negative areas on the other side. From Fig. 4, using the various poles and rays in order, the funicular polygon Fig. 3 is drawn, each string being parallel to its corresponding ray in Fig. 4. When the moment diagram is xm 1, 2, 3..........nx, the funicular polygon in Fig. 3 is the elastic curve and deflections are given five time actual size by the vertical distances between this funicular polygon and the straight line st. In Fig. 3 it is found that the elastic curve is above the line st a distance D at R_2, or we might say that there is a deflection up at R_2. This means that R_2 is 1/5 of D higher than R_1 and R_3 when the moment diagram is xm 1, 2..........nx. It is therefore evident that x was taken too high, and too much moment was assumed to exist at R_2.

Knowing this, point y is chosen, giving a smaller moment at R_2. The closing strings ym and yn are drawn, giving a moment diagram the areas of which are laid off in Fig. 6, and from Fig. 6, Fig. 5 is drawn. Fig. 5 shows that point y gives too little moment at R_2; it really gives the moment which would exist if R_2 were 1/5 D_1 lower than R_1 and R_3. The correct position of z, the one giving the moment at R_2 when the three supports are at the same elevation must be somewhere between x and y. Make xu equal to D and yv equal to D_1 and draw uv, thus locating z approximately.

For a check the closing strings zm and zn are drawn and the areas of this third moment diagram are laid off in Fig. 8 from which the elastic curve Fig. 7 is drawn. This elastic curve should intersect or come tangent to the straight line $s_2 t_2$ at R_2. The error is found to be, e, a very small amount, especially when it is considered that the vertical dimension in this figure has been magnified five times.

The problem has thus been solved and checked. The moment diagram for the case when the three supports are at the same elevation is zm 1, 2..........nz and by drawing rays in Fig. 2, parallel to the closing strings zm and zn the reactions R_1, R_2 and R_3 are found. The magnitude of the moment at any section is found by multiplying the proper intercept in Fig. 1 by the pole distance in Fig. 2.

A very interesting feature of this construction is the fact that, given any moment at the center support, the relative elevation of the three supports can be found by constructing the elastic curve. Or after a careful extension of the curve uzv the moment which will exist at R_2, when R_2 has settled a distance d_x below the other two supports, can easily be found. Measure off $5d_x$, as shown in Fig. 1, and locate the intersection k, from this point project back to the action line of R_2, locating point j. Then jw times H gives the desired moment.



Diagrams for Graphical Solution of Continuous Beams.

Some New Requirements of Illinois Bridge Specifications.—The new general specifications for bridge work (edition of August, 1917), of the Division of Highways of the State of Illinois Department of Public Works and Buildings, requires that all steel bridges having spans of more than 80 ft. shall have cast hinged bolsters on one end and cast hinged rockers on the other end of a design similar to that provided by the standard designs of the Division of Highways. Other new requirements regarding steel bridges include the following:

> The end gussett plates of pony trusses shall be connected to the base plate with angles having 2 rows of rivets in the vertical leg. All bearing surfaces of the base plates and vertical webs shall be planed. No base plate or web connection angle shall have a thickness of less than ½ in.
>
> The end gussett plates of pony trusses shall be connected transversely with a diaphragm.

Construction Costs of Various Types of Freight Handling Wharves

A considerable amount of data concerning the latest and best practice in the construction of freight-handling wharves has been collected by a committee of the American Railway Engineering Association. The information was obtained from members of the association and is summarized in the July Bulletin of the association by Mr. W. H. Hoyt as a portion of an interesting article on the design of docks and wharves. The notes that follow are taken from the above mentioned publication.

Docks at San Francisco, Ferry Point and Oakland, Santa Fe System.—The Atchison, Topeka & Santa Fe Ry. Coast Lines has about 4,000 ft. of frontage of wharf at San Francisco, practically all of which is over a rock seawall and is supported on creosoted piles, spaced 10 ft. each way. The intermediates are 4 in. by 12 and tracks are carried with two pieces of 12-in. by 12-in. under each rail over the 10-ft. spans. At Ferry Point the railway has a wharf 70 ft. wide by 700 ft. long. In 1913 this wharf was extended and a new freight apron built on the end. The extension was designed primarily for the accommodation of barges handling cars. The wharf on either side of this dock was constructed as a support for the spring line of the slip. This also is true of a new slip at Oakland. The latter wharf was driven with a 10-ft. spacing of piles. In all of the wharf work piles treated with 16 lb. of creosote are used for salt water driving. All the above mentioned jobs were constructed by contract covering the labor only, the railway company furnishing all the material. Each contract was made up on the basis of unit prices covering each kind of lumber and the different kinds of piles.

At Ferry Point the unit prices were as follows:

Pulling piles	$15.00	each
Taking out old lumber	6.00	per M
Cutting piles off on present wharf to new grade	1.25	each
Drive and fasten standard piles	9.35	each
Drive and fasten brace piles	15.50	each
Drive and fasten fender and mooring piles	7.15	each
Drive and fasten spring piles	11.00	each
Drive and fasten cluster piles	16.00	each
Drive and fasten dolphin piles	18.50	each
Placing caps	21.00	per M
Stringers and compounds	16.00	per M
Planking	11.35	per M
Guard rail	9.60	per M
Chocks	32.00	per M
Ribbing	31.70	per M
Spring line chocks	45.00	per M
Sheathing	18.50	per M
Intermediate stringers	12.75	per M
Total labor (approximately)	$15,000	

At Oakland the unit prices were as follows:

Drive and fasten standard piles	$ 9.00	each
Drive and fasten brace piles	15.00	each
Drive and fasten dolphin piles	18.00	each
Drive and fasten cluster piles	12.00	each
Drive and fasten spring piles	12.00	each
Placing caps and sub-caps	21.00	per M
Placing stringers and compounds	16.00	per M
Placing intermediate stringers	12.75	per M
Placing planking	11.00	per M
Placing guard rail	9.00	per M
Placing ribbing	34.00	per M
Placing chocks	40.00	per M
Placing sheathing	18.00	per M
Taking up old timber	6.00	per M
Total labor (approximately)	$19,000	

At San Francisco the unit prices were as follows:

Drive and fasten fender piles	$ 8.00	each
Drive and fasten standard piles	8.00	each
Drive and fasten mooring piles	8.00	each
Placing caps	20.00	per M
Compound stringers	16.00	per M
Track stringers	16.00	per M
Intermediate stringers	15.00	per M
Fillers	10.00	per M
Guard rail	10.00	per M
Planking	10.00	per M
Removing old lumber	6.00	per M
Placing chocks	32.00	per M
Breaking off old piles	3.00	each
Pulling piles	12.00	each
Placing sub-caps	25.00	per M
Total labor (approximately)	$17,500	

Pier No. 5, Weehawken, N. J., New York Central & Hudson River R. R.—Designed for handling outward business (boats to cars) only. Built on pile foundations. Has adequate floor space and numerous gangways to make short trucking possible. It is securely sway braced with 4-in. x 8-in. plank bolted to each pile, also girt timbers running across piling underneath wharf. Has double layer deck, consisting of a lower 4-in. plank deck covered with 2-in. x 4-in. beech flooring. The total contract cost of the substructure and superstructure, including heating, dry fire protection line, electric wiring and fire alarm system, was about $3 per square foot.

Pier and Bulkhead Platforms, James Slip and Olive St., New York City.—Has a 9-in. reinforced concrete deck on timber stringers and pile foundation. On top of the 9-in. concrete is a 2½-in. asphalt wearing surface. The front of the wharf is fendered with oak piling and timber securely bolted to the main frame work. The unit costs are stated to be as follows: Timber decks, including rangers, about 52 ct. per square foot; reinforced concrete deck, 46 ct. per square foot, and with 2½ asphalt wearing surface 55 ct. per square foot. The figures for concrete do not include the cost of timber construction at deck level on the sides of the dock.

Dock at Sandusky, O., for Pennsylvania R. R.—This is a new dock for coal machine. It is a good example of filled timber crib on rock foundation with monolithic concrete superstructure. The average height of crib is 18 ft. The unit cost per lineal foot of dock was as follows:

	Per lin. ft. of dock.
Hemlock lumber	$ 35.00
Framing, placing and sinking	25.00
Iron (tie bolts, drift bolts, etc.)	14.00
Stone (for sinking cribs)	12.00
Leveling foundations	2.00
Concrete top	19.50
Cast iron mooring posts	1.50
Total	$109.00

Dock at Port Bolivar, Tex., Gulf, Colorado & Santa Fe Ry.—This dock is a timber platform supported on pile foundations. Back of the dock proper sheet piling has been driven and tied back by ½-in. iron rods to anchor piles, and the dock filled. The geological formation at the site consists of alternate layers of water, sand and sea inlet to an indefinite depth. It is estimated that the cost of a pile foundation for concrete walls with the cost of the necessary caisson work would more than equal the entire cost of the present bulkheads and aprons. The unit costs were as follows:

Total cost of bulkhead per lin. ft	$33.27
Total cost of apron 30 ft. wide per sq. ft	0.7343
Cost per linear foot marine treated piles	0.385
Cost per linear foot untreated piles	0.085
Cost per M. feet B. M. marine treated timbers	47.80
Cost per M. feet B. M. full-cell treated timbers	31.00
Cost per M. feet B. M. untreated timbers	21.80
Cost per linear foot driving marine treated piles	0.17
Cost per linear foot driving untreated piles	0.15
Cost per M. feet B. M. placing marine treated timbers	16.00
Cost per M. feet B. M. placing other timbers	15.00

Average cost of freight on piles about $0.05 per lin. ft., and on timbers about $5 per M. B. M.

Pier No. 9, Hoboken Terminal, Delaware, Lackawanna & Western R. R.—This pier has been in use for about 8 years. It is a 2-story steel and reinforced concrete structure supported on pile foundations stiffened with riprap and rubble filling. The cost was $4.25 per square foot.

Lumber-Handling Dock, Lake Superior, Duluth, Winnipeg & Pacific Ry.—This dock was designed exclusively for handling lumber from railroad cars to boats.

Its cost was as follows:

Engineering charges	$ 1,409
Freight charges on piling, ties and planking	5,089
Piling, 103,185 lin. ft.	17,539
Timber, 818,230 ft. B. M.	22,702
Machine bolts, drift bolts, etc	1,480
Iron cleats, 25, at $8.75	219
Contract price driving piles, 92,791 lin. ft. left in work at 5¾ ct	5,335
Contract price framing deck and bracing, 781,699 ft. B. M. left in work, at $6.90 per M.	5,394
Excavation for mud sills on bank	119
Crib at end of dock:	
Iron rods for tieing crib	19
Labor applying rods	44
Stone for filling crib, 64 cords at $7	448
Dredging, 177,427 cu. yd. at 11 ct	19,517
Track, 60-lb. rail, and fastenings, second-hand	1,689
Track, labor	320
Saunders car stoppers, 2 at $45	90
Freight on car stoppers	7
Total	$81,422

Dock, Toledo, O., Hocking Valley Ry.—This structure is typical of the ore and coal-handling docks on the Great Lakes. It is an excellent sample of crib-filled structures and of concrete pier supported directly on piling. On account of the heavy distributed loads to be carried and the heavy machinery foundations it requires a very solid substructure. It is also thoroughly tied back with anchor rods. The unit tests were:

12-in. x 12-in. timber grillage placed	$43.00	per M. B. M.
2-in. plank, hardwood	38.00	per M. B. M.
2-in. plank, hemlock	35.00	per M. B. M.
Timber piling driven	.28	per lin. ft.
Steel piling driven	.02	per lb.
Concrete placed	6.80	per cu. yd.
Steel "I" beams placed	.02	per lb.
Steel reinforced rods placed	.02½	per lb.
Wrought iron rods placed	.05	per lb.
Dredging and waste	.23	per cu. yd.
Dredging and backfill	.27	per cu. yd.

The above prices do not include company freight or supervision.

Dock on Chicago River, Chicago, Milwaukee & St. Paul Ry.—This is a very simple structure composed of a front row of piling with sheet piling anchored back to anchor timbers and piles with 1¼-in. rods. The dock is then filled. These docks in Chicago and Milwaukee cost from $18 to $25 per lineal foot, depending upon local conditions.

Bituminous Wearing Surfaces for Highway Bridges

For the past four years the Illinois State Highway Department has been using a bituminous mastic for covering old bridge floors. This wearing surface has been recommended only in cases where the existing structure was too good to destroy and where it would not carry the additional dead weight of a new concrete floor. The first mat surfaces were placed by successive applications of a hot bituminous material, similar to that ordinarily used for bituminous macadam construction, and torpedo gravel or stone chips. During the latter part of 1916 the Maintenance Division of the Department began using emulsified asphalt for the bituminous compound, thus permitting the application of a cold bituminous mixture on isolated bridges where it is not convenient, or economical to employ heating apparatus. The emulsified asphalt and aggregate can be mixed in an ordinary concrete mixer, thereby getting a good bituminous concrete.

The new edition (issued in August) of the General Specifications for Bridge Work of the Division of Highways of the State of Illinois contains specifications for both types of these bituminous wearing surfaces. The principal requirements of the specifications follow:

Bituminous Wearing Surface—Hot Penetration Method.

Asphalt.—The asphalt used for bituminous wearing surface shall conform to the following requirements: Asphalt shall have a specific gravity at 25° C. of not less than 0.97 nor more than unity. It shall be soluble in cold carbon disulphide to the extent of at least 98 per cent. Of the total bitumen, not less than 22 per cent nor more than 30 per cent shall be insoluble in 86° B. naphtha. When 20 grams (in a tin dish 2½ in. in diameter and ¾ in. deep with vertical sides) are maintained at a temperature of 163° C. for 5 hours in a N. Y. testing laboratory oven, the evaporation loss shall not exceed 2 per cent and the penetration shall not have been decreased more than 25 per cent. The fixed carbon shall not exceed 16 per cent by weight. The penetration as determined with the Dow machine using a No. 2 needle, 100 gm. weight, 5 seconds time, and a temperature of 25° C. shall be not less than 30 nor more than 50. The asphalt shall contain not to exceed 6 per cent by weight of paraffine scale.

Aggregate. The aggregate shall consist of screened gravel, which shall have been approved by the engineer, dry, free from dust, dirt and clay, and graded in size from ⅜ in. to ¾ in.

Cleaning Sub-Planking.—Before placing the wearing surface, the sub-planking shall be thoroughly cleaned from all foreign material and the cracks shall be filled and the plank covered to a depth of approximately ⅛ in. with asphalt of the character herein specified, which shall be applied at a temperature of not less than 400° F. The sub-planking shall be dry when the asphalt is applied.

Placing Wearing Surface.—The gravel shall be spread on the asphalt covering while the same is hot and in a quantity which will just cover the asphalt. The thickness must not exceed that which will be formed by a single layer of the gravel pebbles.

Upon the material thus spread, there shall be poured hot asphalt until the interstices are all filled, the asphalt being at a temperature of not less than 400° F.

Upon the layer of asphalt thus poured there shall be spread a second layer of gravel which shall not exceed the thickness of a single layer of pebbles, but which must be spread in sufficient quantity to cover completely the layer of asphalt.

Upon the layer of gravel thus spread there shall be poured hot asphalt until all the interstices are filled, the asphalt having a temperature of not less than 400° F.

Finish.—The surface shall then be covered with a layer of pebbles just sufficient to cover the asphalt, the pebbles to well rolled or tampered into the asphalt and the surface finally covered with coarse sand sufficient to take up any free asphalt. After the surface has stood for one day, it may be opened to traffic.

Bituminous Wearing Surface—Cold Mixing Method, Using an Asphalt Emulsion.

Asphalt Emulsion.—The emulsion shall consist of asphalt, water and fatty or resin soap thoroughly emulsified. It shall conform to the following requirements:

Total bitumen	Not less than 60.0 per cent
Specific gravity of dehydrated material	Not less than 1.000
Penetration of dehydrated material, 25° C., 100 gms., 5 sec.	150 to 200

Total Bitumen.—The total bitumen shall be considered as being 100 minus the sum of the percentages of water, of fatty or resin acids, of organic matter insoluble in carbon disulphide other than fatty or resin acids from the soap, or mineral matter (ash), and of ammonia.

For percentages of water, fatty or resin acids, organic matter insoluble in carbon disulphide, mineral matter (ash), and ammonia, United States Department of Agriculture Bulletin 314, p. 41.

Specific Gravity. Standardized pycnometers, United States Department of Agriculture Bulletin 314, p. 4.

Penetration.—A. S. T. M. Stand. Test D 5-16.

Aggregate.—The aggregate shall consist of crushed stone chips uniformly graded from ¾ in. down to dust with all dust removed, to which shall be added sufficient sand to fill all remaining voids, but not to exceed 20 per cent of the volume of the aggregate.

Cleaning Sub-Planking.—Before placing the wearing surface, the sub-planking shall be thoroughly cleaned from all foreign material and all cracks shall be filled with wood strips or oakum.

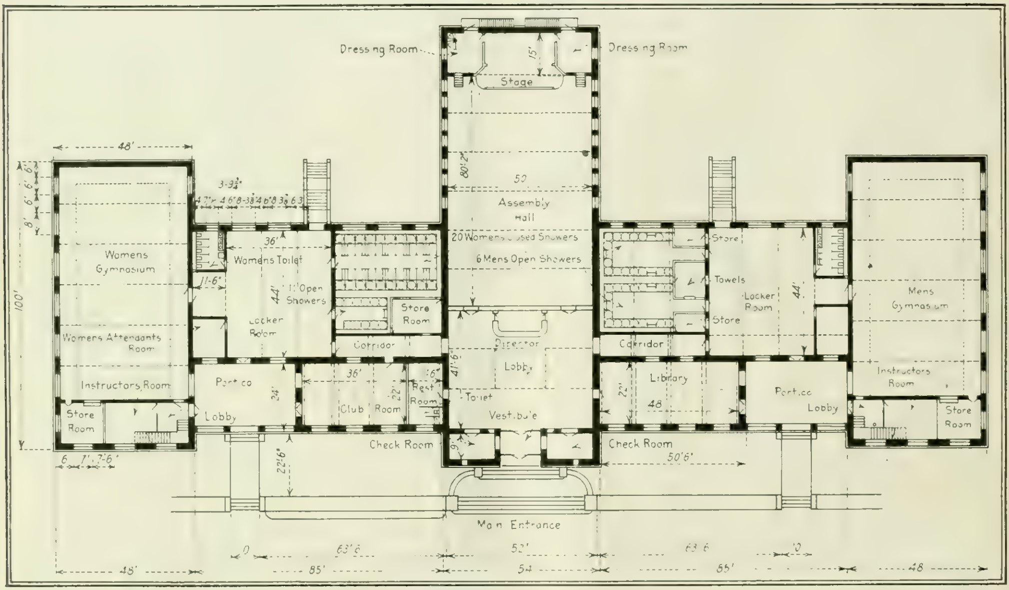
Mixing Materials.—The aggregate and the asphalt emulsion shall be mixed cold in the proportions of 1 gal. of emulsion to 1 cu. ft. of aggregate. To facilitate mixing, water to the extent of 20 per cent may be added to the emulsion. The proportions given above for mixing the aggregate and the emulsion are based on the undiluted emulsion. The mixing shall be done on a tight mixing board or in a batch concrete mixer, and shall continue until all particles of the aggregate are thoroughly coated.

Placing Wearing Surface.—After mixing, the material shall be spread upon the roadway in sufficient quantity to provide a thickness of ¾ in., after rolling or tampering.

Finish.—After the material has been rolled or tamped smooth and to a uniform thickness of ¾ in., the surface shall be given a paint coat of the emulsion applied at the rate of ¼ gal. per square yard, and then shall be covered with coarse sand sufficient to take up any free asphalt and to fill all voids in the surface. After the surface has stood for one day, it may be opened to traffic.

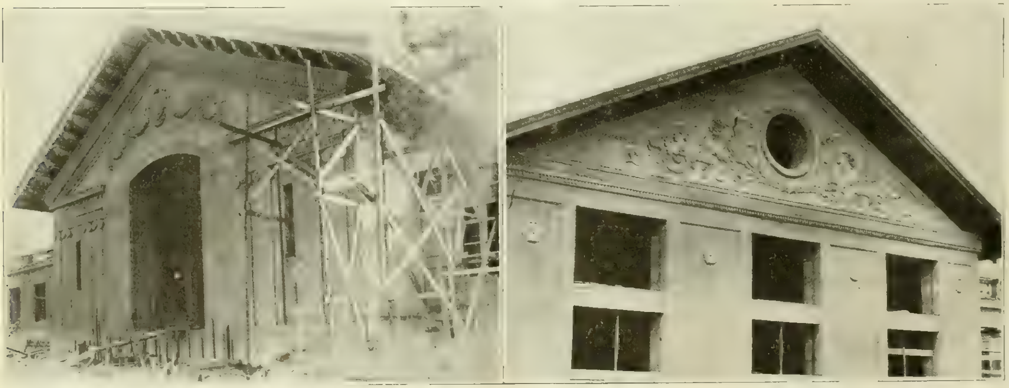
Design and Construction Features of New Buildings of South Park Commissioners of Chicago

The remarkably pleasing appearance at low cost which the South Park Commissioners of Chicago have attained during the last few years in buildings erected in the large number of parks under their jurisdiction is brought to highest development in a new group of structures under construction in McKinley Park. This park is located in the southwestern part of the city and has an area of 54 acres. The new buildings form the recreation center and consist of a large T-shaped structure and a power plant. The general dimensions of the large building are: Length, 320 ft.; central axis, 152 ft.; axis of the women's and men's gymnasiums, located at the ends of the structure, 100 ft.



First Floor Plan of Group of Park Buildings, McKinley Park, Chicago, Ill.

The feature of greatest interest in these buildings is a monolithic concrete construction in which a rough uniform surface wall texture is obtained without tooling or any kind of acid treatment. In the central and two end facades of the front of the new group of buildings the rough surface texture has been carried into more ornamental design by the extensive use of plaster cast forms than has been heretofore attempted in this style of surface. A great improvement in the design of these buildings as compared with others built by the South Park Commissioners is that they are so grouped that every department connects directly with the director's office, situated in a large lobby in the center of the structure.



Examples of Rough Surface Finish of New Park Buildings of South Park Commission.

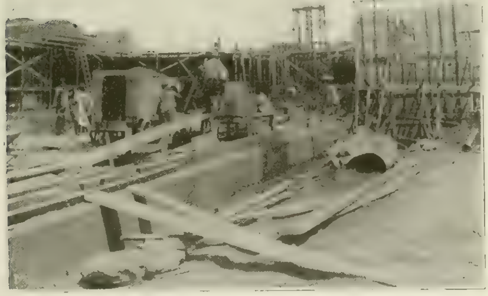
The women's end of the building contains a gymnasium with lobby, instructor's room and store room;

locker room with attendant's room and toilet; separate shower rooms for women and girls, the women's showers being enclosed in separate booths; club room and rest room. The gymnasium, locker room and club room are entered from a wide portico. The men's end of the building is similar in design to the women's end except that it contains a library room in place of the club and rest rooms. The center of the building is occupied by the lobby, check rooms and a large assembly hall equipped with stage and dressing rooms.

The usual style of wood forms were used for the walls, the forms being set up both horizontally and vertically as conditions required. For many of the panels and pilasters the forms were set vertically. The wall is made up of a central core of 4-in. hollow tile faced on either side with concrete, the tile being anchored into the concrete. The tile were laid in 12-in. courses followed by 12-in. courses of the concrete on either side. This permitted the concrete to be so laid that the line of break between two courses would be opposite the center of a course of tile.

The specifications for the aggregates in all exposed walls called for 2 parts of cement to 3 parts of torpedo sand and 9 parts of crushed limestone, the limestone to be screened to sizes that all would flow over a ⅛-in. mesh and pass a ⅜-in. mesh. A thorough machine mix using a very small quantity of water is one of the most important features in producing this uniform rough surface texture concrete. The rule was to use only sufficient water so that the mixed concrete would adhere when firmly pressed in the hand. When placing the concrete it was tamped very hard in the center of the wall adjoining the tile core and very little near the surface.

The contract for all concrete work was let to Schillinger Construction Co., 2322 N. Seeley Ave., Chicago, who used for mixing the larger part of the concrete a ⅓-yd. "Standard" low charging mixer. The portability of this mixer enabled it to be moved along as the work progressed and by distributing the aggregates around the building the concrete could be mixed and placed with least hand wheeling.



Construction View of New South Park Buildings.

All plans for these buildings were made by the engineering department of the South Park Commissioners under the direction of Mr. Linn White, Chief Engineer. Representatives of the South Park Commissioners say that the design and arrangement of these buildings are superior to any they have hitherto produced for park recreation purposes.

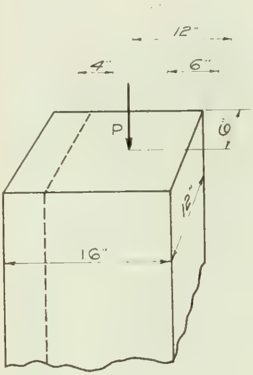
An Eccentric Loading Experiment

By J. A. VANDEN BROCK,

Instructor in Engineering Mechanics, University of Michigan.

The theory of eccentric loading, leading to the formula $f = \frac{P}{A} + \frac{P \times e \times c}{I}$ is one of the theories in strength of materials most open to criticism as displaying disagreement between theoretical conclusions and supposed common-sense conclusions.

For example, when the above formula proves that a column having a cross section of 12 in. x 16 in. and loaded 6 in. from three sides and 10 in. from the fourth side (as shown in sketch) may be strengthened by removing a slice 4 in. thick as if cut along the dotted line and reducing it to a column 12 in. square loaded in the center, the soundness of the theory and the accuracy of the formula is likely to be questioned.



The accompanying photograph and table are taken from an experiment in a student's course in testing materials at the University of Michigan, designed by the author to test the theory and verify the formula.

A 9-in., 21-lb., I-beam 24 in. long was loaded as a column. The ends of the column were faced and heavy bearing blocks were made to fit. Grooves were cut into the bearing blocks into which steel rods would fit to give eccentricities of 0, 1, 2, 3 and 4 in., respectively. One rod was placed on the table of a 200,000-lb. capacity testing machine. One bearing block was then placed upon it with the rod fitting the groove that would give the desired eccentricity.

The column with the second bearing block and rod were subsequently placed. After plumbing the whole arrangement, the crosshead of the machine was brought down.

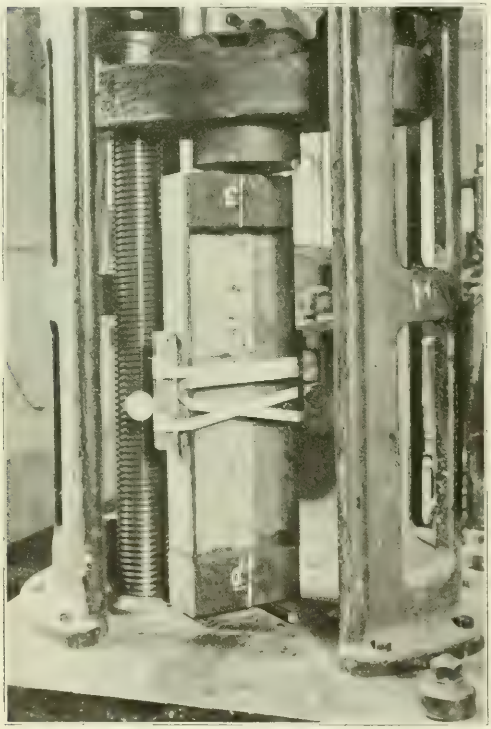
Two 8-in. Berry strain gages were fastened with elastic ribbons on opposite flanges of the column as shown in the photograph.

The Berry strain gage consists of a steel frame to which two points are fastened 8 in. apart. One of the points is fixed; the other point turns around a pivot and is part of a lever extending inside of the steel frame to underneath the Ames dial. As the specimen is compressed the points on the gage move closer together; the invisible part of the lever moves out from the column and bears against the Ames dial. The Ames dial records this motion, called y_1 and y_2 in the table. This reading must be divided by 5 to give the movement of one of the gage points relative to the other and again divided by 8 to give the strain or the shortening of the column under the gage in question in terms of inches per inch. This strain multiplied by the modulus of elasticity (E) gives the stress f_1 and f_2.

During the progress of the experiment the load was applied by suitable increments and simultaneous readings of load and strain gages were taken.

Table I gives the results of one experiment. The actual stress in Columns 4 and 5 is figured on the assumption E = 29,000,000 lb. per square inch. A comparison between Columns 3 and 8 and between 4 and 9 shows that the actual and theoretical stresses in the steel check very closely and well within the possible experimental error. It appears therefore that the formula is exact and the theory unquestionably right, and variation from the formula can only be expected where the assumptions on which its development are based are violated.

The most fundamental assumption underlying the theory is the assumption that the material in question is elastic. Steel was selected for the experiment as the most elastic material obtainable, but even hot rolled steel is not perfectly elastic under very low stresses, the modulus of elasticity, E., for stresses under about 5,000 lb. per square inch ordinarily being higher than for a range of stress from 5,000 lb. per square inch to 30,000 lb. per square inch. This discrepancy, together with some possible error in the assumption of the value of E easily accounts for the slight differences between theoretical and actual stresses.



Eccentric Loading Test.

The table shows that with an eccentricity of 3 in. the extreme fiber stresses on one side of the column are zero and on the other side of the column are double the average stress; while with an eccentricity of 4 in. tensile stresses were developed in the extreme fibers on one side of the column.

TABLE I. - ECCENTRIC LOADING EXPERIMENT GIVING LOADS, ACTUAL STRESSES MEASURED WITH STRAIN GAGES AND THEORETICAL STRESSES COMPUTED BY FORMULA

$$f - \frac{P}{A} - \frac{P \times e \times c}{I}$$

Gage No. 1, Y_1.	Gage No. 2, Y_2.	Actual stress, $f_1 = Y_1 \times \frac{E}{40}$	Actual stress, $f_2 = Y_2 \times \frac{E}{40}$	Load, P.	$f = \frac{Mc}{I} = \frac{P \times e \times c}{I}$	$\frac{P}{A}$	Theoretical stress, $f_1 = \frac{P}{A} + \frac{Mc}{I}$	Theoretical stress, $f_2 = \frac{P}{A} - \frac{Mc}{I}$	Eccentricity, e.
0	0	0	0	0	0	0	0	0	0"
.0090	.0089	6530	6450	42160	0	6670	6670	6670	0"
.0183	.0180	13300	13050	85500	0	13550	13550	13550	0"
.0304	.0306	22000	22200	133000	0	21100	21100	21100	0"
0	0	0	0	0	0	0	0	0	1"
.0132	.0068	9580	4930	46070	2435	7300	9735	4865	1"
.0258	.0129	18700	9350	89500	4730	14200	18930	9470	1"
.0330	.0166	23900	12050	114550	6030	18150	24180	12120	1"
0	0	0	0	0	0	0	0	0	1"
0	0	0	0	0	0	0	0	0	2"
.0112	.0020	8120	1450	31660	3355	5030	8380	1675	2"
.0209	.0040	15150	2900	59700	6330	9480	15810	3150	2"
.0311	.0061	22550	4430	85760	9070	13600	22670	4530	2"
0	0	0	0	0	0	0	0	0	2"
0	0	0	0	0	0	0	0	0	3"
.0104	0	7540	0	25810	4090	4090	8180	0	3"
.0212	0	15400	0	51340	8130	8140	16270	0	3"
.0353	0	25600	0	83000	13170	13170	26340	0	3"
0	0	0	0	0	0	0	0	0	4"
.0098	—.0012	7100	—870	20570	4350	3250	7600	—1100	4"
.0223	—.0029	16200	—2100	45100	9550	7150	16700	—2400	4"
.0350	—.0049	25400	—3550	70000	14800	11100	25900	—3750	4"
0	0	0	0	0	0	0	0	0	4"

Size of I beam, 9-in. Weight, 21 lb. 1 ft. Area, 6.31 in.^{2}. I/c = 18.9 in.^{3}. E = 29000000 lb. in^2. Minus sign (—) signifies tensile stress.

The theory of eccentric loading is applied to retaining walls, dams, column footings and arch rings possibly more frequently than to steel columns. In all the above named instances the cross section on which the stresses are computed is rectangular and the theory of loading proves the resultant load must cut the section within its middle third in order to avoid tensile stresses in the structure.

In our experiment, an eccentricity of 3 in. corresponds to a resultant cutting a rectangular section at the one-third point, while an eccentricity of 4 in. corresponds to a resultant cutting a rectangular section outside of the middle third of the section.

Rail Inclination, Wheel Coning and Tie Plates.—Our attention has been called to an error in the captions of the illustrations of the above mentioned article which appeared in our July 25 issue. The title of Fig. 1 should have been "Results of Rail Wear After One Year's Service"; Fig. 3 should have been "Wear on Rail Laid Normal to Ties."

The U. S. Navy Department will hold an examination shortly to obtain eligibles to fill at least 10 existing vacancies in the grade of Assistant Civil Engineers, Corps of Civil Engineers, U. S. Navy. Candidates must not be over 26 years of age, must be citizens of the United States. They must be a graduate from a college or university and must have had at least 14 months' practical professional experience since graduation. The salary and allowances approximate $2,500 per year. Further particulars may be obtained from the Chief of Bureau of Yards and Docks, Navy Department, Washington, D. C.

The American Association of Engineers now has a total enrollment of over 2,200. Since the association was incorporated about 2 years ago 7 chapters have been organized, the last three being in St. Paul, Milwaukee and Indianapolis.

Economics of Bridge Design*

It has been found by experience that, for trusses with polygonal top chords, the economic depths, as far as weight of metal is concerned, are generally much greater than certain important conditions will permit to be used. For instance, especially in single-track, pin-connected bridges, after a certain truss depth is exceeded, the overturning effect of the wind-pressure is so great as to reduce the dead-load tension on the windward bottom chord to such an extent that the compression from the wind load carried by the lower lateral system causes reversion of stress, and such reversion eye-bars are not adapted to withstand. A very deep truss requires an expensive traveler, and decreasing the theoretically economic depth increases the weight but slightly; hence it is really economical to reduce the depth of both truss and traveler. Again, the total cost of a structure does not vary directly as the total weight of metal, for the reason that an increase in the section area of a piece adds nothing to the cost of its manufacture, and but little to the cost of erection; consequently it is only for raw material and freight that the expense is really augmented. Hence it is generally best to use truss depths considerably less than those which would require the minimum amount of metal. For parallel chords, the theoretically economic truss depths vary from one-fifth of the span for spans of 100 ft. to about one-sixth of the span for spans of 200 ft.; but for modern single-track railway through-bridges the least allowable truss depth is about 30 ft., unless suspended floor-beams be used, a detail which very properly has gone out of fashion.

In designing plate-girders, if one will adopt such a depth as will make the total weight of the web with its splice-plates and stiffening angles about equal to the weight of the flanges, he will obtain an economically designed girder, and a deep and stiff one. For long spans, however, this arrangement would make the girders so deep as to become clumsy and expensive to handle; consequently, when a span exceeds about 40 ft., the amount of metal in the flanges should be a little greater than that in the web; and the more the span exceeds 40 ft. the greater should be the relative amount of metal in the flanges.

A rather lengthy mathematical investigation for plate-girders, based upon fairly accurate assumptions, proves that the theoretical maximum of economy exists when the gross areas of flanges and of web at mid-span are equal—a condition readily remembered. Although this is the theoretically correct criterion for economy, if it be applied to any particular case, it will generally be found that the resulting web depth is so excessive as to cause one or more of the following modifications in construction, as compared with the depth which would make the total weight of the flanges equal to the total weight of the web with all its details:

A. An additional splice or two in the web, or else a slightly increased pound price for the large plates. B. Larger outstanding legs for all stiffening angles. C. Reduction in the number of cover plates. D. Narrowing of flange angles and necessitating thereby either an additional bracing frame or an increase in sectional area of the compression flange, in order to compensate for the greater ratio of unsupported length to width. E. Possibly thickening of web because of its greater depth. F. Possible encroachment on under-clearance in deck spans, or raising of grade to avoid the same. G. Possible difficulty in fabrication or shipment in case of long or heavy girders because of excessive depth.

Any of these changes would be likely so to upset the economics of the case as to cause a material decrease in the theoretically best depth, hence it is generally advisable to adhere to the rule previously given; but there are occasionally cases where a saving of metal may be effected by making the web depth somewhat smaller, when by so doing a web-splice may be avoided or lighter stiffening angles may be adopted. It should be borne in mind that there is quite a range in web-depths over which the theoretic minimum weight is about constant, unless the thickness of the shallower web must be increased on account of shear; hence one may often vary the dimensions of a plate-girder materially without affecting greatly the matter of economics.

Concerning economic panel lengths, it is safe to make the following statement: Within the limit set by good judgment and one's inherent sense of fitness, the longer the panel the greater the economy of material in the superstructure. Of course, when one goes such an extent as to use a 30-ft. panel in an ordinary single-track railway bridge he exceeds the limits referred to, because the lateral diagonals become too long, and their inclination to the chords becomes too flat for rigidity. Again, an extremely long panel might sometimes cause the truss diagonals to have an unsightly appearance because of their small inclination to the horizontal.

There is another mathematical investigation which is of practical value. It relates to the economic lengths of spans. The principle is that "for any crossing the greatest economy will be attained when the cost per lineal foot of the substructure is equal to the cost per lineal foot of the trusses and lateral systems." The old practice was to make for economy the cost of a pier equal to the cost of the span that it supports, or, more properly, equal to one-half of the cost of the two spans that it helps to support. Is not the difference between these two methods perfectly plain? In one the cost of the pier is made equal to the cost of the trusses and laterals, and in the other it is made equal to the cost of the trusses, laterals and floor system. When one considers that the cost of the floor system is sometimes almost as great as one-half of the total cost of the superstructure, he will recognize how faulty the old method was.

The demonstration proves that in any layout of spans, with the conditions assumed, the greatest economy will be attained when the cost of the substructure per lineal foot of bridge is equal to the cost per lineal foot of the trusses and lateral systems. Of course, no such condition as a bridge of indefinite extent ever exists, nor is the bed-rock often level over the whole crossing; nevertheless the principle can be applied to each pier and the two spans that it helps to support by making the cost of the pier equal to one-half of the total cost of the trusses and laterals of the said two spans.

The principle will apply also to trestles and elevated roads; for in the latter, when there is no longitudinal bracing, if we make the cost of the stringers or longitudinal girders of one span equal to the cost of the bent at one end of same, including its pedestals, we shall obtain the most economic layout. In an ordinary railroad trestle consisting of alternating spans and towers, it will be necessary for greatest economy to have the cost of all the girders in two spans (one span being over the tower) plus the cost of the longitudinal bracing of one tower equal to the cost of the two bents of said tower, including their pedestals.

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*From a lecture by Dr. J. A. L. Waddell before the School of Engineering of the University of Kansas.

The economics of reinforced concrete bridges have not received much attention from technical writers. In general, it may be said that the unit costs are lower for those structures which have the simplest form-work; and a reduction will also be effected by decreasing the area of form-surface per cubic yard of concrete. For instance, in the case of a wall or slab the form-cost per cubic yard will vary practically inversely as the thickness of the said wall or slab. Evidently, therefore, it is desirable to concentrate the concrete into a few large members, rather than to employ a great number of small ones.

It should be noted that reinforcing bars less than ¾ in. in diameter command higher pound prices than do the larger bars.

Taking up, first, girder bridges carried on columns, the following points must be considered: First. The panel length, when cross-girders are employed; second, the number and spacing of the longitudinal girders; third, the number of columns per bent; fourth, the span length; fifth, the use of reinforced concrete piles to carry the footings.

The panel length adopted is usually not of great importance from the standpoint of economy. Lengths of from 8 to 10 ft. are generally employed; but a considerable variation from these values will cause little change in the combined cost of the slabs and cross-girders. A reduction in concrete quantities can frequently be effected by using long panels, and by carrying the slabs on short stringers supported by the floor-beams; but the extra form-work required will generally overbalance this saving in volume.

The number and spacing of the longitudinal girders will depend upon the width and the height of the structure, the span-length, and the load to be carried. For a high structure in which the economic span-length is fairly long, it will nearly always be found best to employ two lines of girders, the spacing thereof being equal to about five-eighths of the total width of the structure; but for bridges much over 60 ft. wide, the use of three or even four lines may be preferable. The slab in such structures is carried on cross-girders and cantilever-beams. For a low bridge in which the economic span-length is short, it will generally be the cheapest to omit the cross-girders, except at the bents, and to employ several lines of longitudinal girders. The wider the structure, the more likely will this arrangement prove to be economical; and very heavy loads also favor its adoption. For a structure in which the span-length is from one-half to two-thirds of the width, it will usually make little difference which of the two types is adopted, unless the height is rather large; and even in extreme cases the variation between the two is not likely to exceed 10 per cent. Ordinarily, it will be found more desirable to use two lines of girders, with cross-girders and cantilevers about 8 or 10 ft. centers.

The proper number of columns per bent depends on the number of longitudinal girders. When there are only two lines, two columns will, of course, be employed. When there are several lines of girders, there should generally be one column per girder in low structures, and two columns per bent in higher ones. In this latter case a heavy cross-girder will be required at each bent to carry the longitudinal girders.

The economic span-length is affected by the height and the load, being larger for greater heights and smaller for heavier loads. An approximate value thereof is given by the formula

$$l = h\left(0.3 + \frac{2000}{w + 1000}\right)$$

in which l = economic span length, center to center of supports,

w = load per lineal foot of girders (excluding its own weight), and

h = fixed height of structure.

The quantity h represents in any given case the height which is fixed, such as the height from grade to top of footing, height from grade to bottom of footing, height from underside of girder to top of footing, as the case may be. There is always a considerable range of lengths for which the quantities remain nearly constant. The formula gives values a trifle greater than those for which the quantities are a minimum, since the use of heavier sections will reduce slightly the unit costs of the concrete.

Reinforced-concrete piles should be used under footings when a suitable foundation is to be found only at a considerable depth, or when a very large footing area would be required in order to reduce the pressure to a proper amount. A comparison must be made for each case as it arises, allowing properly for the cost of the column shaft, the footing, the piles, and the excavation. This latter item must not be overlooked.

In arches the problem is much more complicated than in girder spans. The factors that affect the economic lengths are the cost of the arch ribs and that of the piers and abutments, the dividing lines between them being the verticals through the springing points. For any fixed span-length the greater the rise, up to a limit of nearly one-half of the opening, the smaller will be the costs of both the arch and the piers or abutments which sustain it; but in most cases the distance from grade to ground is too small to permit the adoption of such a large rise; hence the problem generally resolves itself into a determination of the question, "How long can the span be made economically for a certain limit of rise?" This will be influenced by several important considerations, among which may be mentioned the following:

A. The live load used. B. The amount of earth fill, if any, over the arches. C. The depth of the foundations for the piers and abutments below the springing points. D. The cost per cubic yard for putting the bases of piers and abutments down to a satisfactory foundation. E. The necessity for a heavy or substantial appearance of the piers and abutments. F. The height to which the large pier shafts must be carried. G. The condition of the arch barrel—whether solid or ribbed. H. The necessity, or otherwise, of adopting certain span-lengths to meet existing conditions.

Here are too many variables for a theoretically correct economic investigation, hence the surest and most satisfactory way to proceed is to make by judgment the best possible layout consistent with the conditions, then two others, one involving a span-length a certain number of feet greater and the other a span-length the same number of feet less, and figure the costs of arches and piers (or abutments) for all three cases. Instead, though, of increasing and decreasing the span by a certain number of feet, it may be necessary to reduce and augment the number of spans by unity. After the costs of the arches and piers or abutments are found and properly combined, the cost of these two portions of the construction per lineal foot of span for each of the three layouts can be computed and compared. The one which gives a minimum will indicate approximately the best span-length to adopt.

In some cases it will prove to be economic to make the middle span of the bridge a certain length and reduce gradually the lengths of the spans at each side. If the configuration of the crossing will permit of a symmetrical layout on this basis, the effect will prove to be pleasing to the eye and generally economic of first cost, especially if a constant ratio of rise to span be maintained; because, as far as cost of substructure is concerned, the overturning moments from live load on a single span only and from inequality of dead load thrusts are kept low, owing to the fact that the lighter thrusts in the smaller span act with a greater lever arm than do the heavier thrusts of the longer span, on account of higher location of the points of springing. In adopting this expedient, though, care has to be exercised to prevent the principles of esthetics from being violated.

Comparing rolled I-beam and plate-girder deck spans for modern heavy live loads, the weights of metal are about equal for spans of 15 ft.; but the former are cheaper per pound than the latter by about 0.4 ct., consequently the costs per lineal foot erected are equal to a span of about 20 ft.

Comparing deck plate-girders and through, riveted truss-spans, for which there is usually a difference of about ½ ct. per pound erected in favor of the former, the weights of metal per lineal foot are the same for spans of 115 ft., which is about the extreme limit of length for plate-girder spans shipped in one piece; hence it may be concluded that for all practicable lengths, deck plate-girder spans are more economic than through, riveted truss-spans. Besides, the use of such deck spans effects a great economy in the substructure by reducing the length of each pier from 6 to 10 ft., the longer the span, of course, the less the reduction. It generally reduces also the heights of the piers.

Comparing half-through, plate-girder spans and through, riveted truss-spans, for which there is a difference of about 0.2 ct. per pound erected in favor of the former, the weights of metal per lineal foot are the same for spans of 70 ft., but the costs per foot are about equal for spans of 75 ft. However, as plate-girder spans are in many respects more satisfactory than short, through, riveted spans, the dividing point is generally placed at about 100 ft.

Comparing Pratt and Petit truss-spans, for which there is no difference worth mentioning in the pound prices of the metal, the weights per foot (and therefore the costs) are alike for single-track spans of 300 ft., and for double-track spans of 350 ft.; but both constructive and esthetic reasons necessitate limiting the lengths of Pratt trusses to about 325 ft.

The economics of column spacing for bents when cantilever brackets are employed is an interesting little problem, but the final determination must be in accordance with good judgment as well as economy; for if the spacing be too small, rigidity is likely to be sacrificed. Upon certain assumptions of approximate correctness, the mathematical solution of this problem is a possibility; but the equations involved would be so complicated that it is much better for any particular case to assume two or three spacings, compute the total weight of metal in the bent for each, and find the one which will give approximately the least weight of metal. If the columns are placed at the quarter points of the beam, the dead load bending moment at the middle will be approximately zero; and if the effect of stress reversion is ignored, the direct and reverse bending moments for the central portion of the beam will be equal, and this arrangement would be about the most economical possible. But if the reversion is considered, the sectional area of the middle portion of the beam must be greater than that of the outside portions, hence for economy its length should be somewhat less than one-half of the total, and the columns would then be spaced somewhat closer than when they are located at the quarter points. The fact that the brackets are usually lighter near the outer ends than at the inner ones would, for economy, tend to draw the columns together; but on the other hand this would increase the weight of the splices and connecting details. The proper column spacing to adopt will depend upon the length of the columns; for it is easily conceivable that the structure could be so high and so narrow that the quarter-point spacing would be too close for proper resistance to wind pressure. Again, in such a case the wind load might be so great as to necessitate an increase in column section above that required to care for the live and dead load stresses only; and thus the effect of wind pressure would enter the economic study. It will be found in most cases that it is inadvisable to space the columns much less than one-half of the total length of the beam.

The economic functions of swing spans are somewhat difficult to formulate. The minimum perpendicular distance between central planes of trusses for first-class construction should be the same as for simple-truss spans—viz., one-twentieth of the span length. It is evident, of course, that the narrower the bridge the less it will weigh and cost. The truss depth at ends of through swing bridges are generally determined by the clearance requirements; but in long spans it is sometimes advisable, for the sake of vertical stiffness and to avoid the raising of span-end from a load on the other arm, to make the said depths still greater. As a rule, this increase is not of an uneconomic nature. For long spans, or those exceeding, say, 400 ft., the truss depth at outer hips should be about 1/14th or 1/15th of the total span length. The truss depth at the inner hips should generally be from 1/9th to 1/10th of the total span length; and when towers are used, their height should generally be from 1/6th to 1/7th of the span. Of course the esthetic features of the design should govern greatly the determination of all these depths; and, fortunately, any moderate change in them does not affect materially their economics.

In swing spans it is evident that, as far as is consistent with safety, the diameter of the drum for economy should be made as small as possible, not only because this effects a saving of metal, but also because it reduces the diameter, and therefore the cost, of the pivot pier. For spans of moderate length and width there is generally a small economy in center-bearing swing-spans over rim-bearing ones, especially as the former sometimes permit of smaller pivot piers, but the difference is often inconsiderable. There is a limit to the size of center-bearing swing-spans due to the objectionable feature of concentrating great loads upon small areas and to the necessity in the case of very wide spans for excessively heavy cross-girders. The question of economics between the two styles of swings is one that has to be determined for each special case as it arises by preparing actual estimates and not by a priori reasoning.

In respect to the economics of cantilever bridges the following may be stated:

The economic length of the suspended span is about three-eighths of the length of the main opening, but a considerable increase or decrease of this proportion does not greatly change the total weight of the metal.

The most economic length of anchor arms, where the total length between centers of anchorages is given, and when the main piers can be placed wherever desired, is one-fifth of the said total length. By keeping the anchor arms short, the top chords may be built of eye-bars, provided that, with the usual allowance for impact, there is no reversion of chord stress; and this effects quite an economy of metal. But it is conceivable that cases might arise where, from danger of washout of falsework, eye-bar top chords would be objectionable; hence this method of economizing must be used with caution.

In respect to the economic length of anchor-span in a succession of cantilever spans, it may be stated that within reasonable limits the shorter such anchor-spans are the greater will be the economy involved; but, generally, navigation interests will prevent their being built as short as might be desired. If permissible, they may be made so short that, as in the case of anchor-arms, eye-bars may be used for the top chords, thus effecting a decided economy of metal, although shortening the anchor-span increases proportionately the stresses on the web members and the weights thereof.

The question of what is the economic limit of length of simple-truss spans as compared with cantilevers is still a mooted one. Professors Merriman and Jacoby place it in the neighborhood of 600 ft., but the speaker has had occasion to compare simple-truss spans of 700 and 800 ft. with the corresponding cantilever structures, and has found the former more economic. The continuity of cantilever spans in resisting wind loads lowers the requirements for minimum width from one-twentieth to about one twenty-fifth of the greatest span-length, and hence, because of substructure considerations, gives an advantage to the cantilever type that in certain extreme cases will more than offset its disadvantages of greater weight of truss metal.

There are certain legitimate economies that may be employed in the designing of cantilever bridges, among which may be mentioned the following:

The wind pressure assumed in computing the erection stresses may be taken lower than that given in the specifications for the finished structure, provided that the full wind pressure would not overstress any of the metal seriously or involve any risk of disaster during erection. A stress of three-quarters of the elastic limit of the metal applied a few times during erection would do no harm, and the chance of there being in that limited time any wind pressure at all approaching in magnitude that specified is very small. This lowering of the intensity of wind pressure may be the means of avoiding, in a perfectly legitimate manner, the increasing of the sections of a number of truss members because of erection streses; but such economizing should be done with caution after a thorough consideration of its greatest possible effects.

A certain amount of metal can sometimes be saved by splaying the trusses between the main piers and the ends of the cantilever and anchor arms; but unless the amount thereof be fairly large, the extra pound price of the metal work in the cantilever and anchor-arms due to the said splaying may more than offset the value of the reduction.

A small economy may sometimes be accomplished by omitting during erection from the cantilever portion of the structure all parts that are not essential to its strength before the coupling of the cantilever ends is effected, thus reducing the erection stresses a little.

Solitary piers or large pedestals under the main vertical posts are sometimes just as satisfactory in every way as long, continuous piers, especially if a connecting wall of reinforced concrete between them be employed. Generally they will be found to involve a large saving in the cost of the substructure.

In very wide cantilever bridges it might sometimes be advisable to adopt intermediate trusses so as to economize materially in the weight of the floor-beams and a trifle in that of the trusses, also because of the consequent reduction in dead load, but mainly so as to keep within reasonable limits the sizes and weights of the pieces to be handled and thus economize on the size of the traveler and the cost of the erecting machinery. On the other hand, though, increasing the number of trusses is likely to increase a little the percentage of weight of truss details; but where the sections of members are large, this increase would be small. In case the wind stresses are an important factor in the proportioning of the truss members, the employment of an interior truss or interior trusses might, by the reduction in areas of chord sections, cause such relatively large wind stresses on the chords of the exterior trusses that the additional metal required to take care of them would offset all the saving obtained in the ways just mentioned.

In long-span cantilever bridges the stresses on the truss members that rest upon the piers should be divided among as many such members as possible by using an inclined strut on each side as well as a vertical post instead of carrying all the loads to the top of the latter by tension members, as was done in the design of the ill-fated Quebec bridge. Again, if a lowering of the inner ends of the cantilever arms be permissible, the inclining of the end sections of the bottom chords to the horizontal will take up a portion of the load that is carried to the pier and thus will reduce the stresses on the vertical and inclined posts assembling there. This last feature reduces also the total cost of the masonry by diminishing the height of the main piers, and saves placing the tops of the trusses at an abnormal height above the water.

If there be any choice between the riveted and the pin-connected types of construction for any cantilever bridge, it is generally better to adopt the latter, because, as cantilever bridges are usually employed for long spans only, pin-connected work is the more suitable. Again, it is a little lighter than riveted work, and therefore the dead load on the structure would be somewhat less. On the other hand, the riveted construction is so much more rigid than the pin-connected that it is preferable to adopt it whenever the conditions permit; besides, in the riveted work it is not necessary to stiffen any truss members for erection, although it might be obligatory to increase a few of their sectional areas.

Very large compression members should be made of box section so as to do away with latticing. This not only effects an improvement in the design, but also saves some metal, although the details required at the panel points to distribute the stresses from the cut cover plates tend to offset the saving in weight of lattice bars and stay plates.

Questions of erection often not only affect the economic layouts of crossings, but also determine the character of the spans to be adopted. For instance, if the danger from washout of falsework be great, either a cantilever or a semi-cantilever structure may be better than one of simple spans, or a pin-connected structure may be preferable to a riveted one, even if the computations of cost made upon the basis of good luck in erection indicate that the contrary is the case. Again, the chance of not getting the substructure finished before high water or bad weather causes a cessation or partial cessation of work might so affect the layout of spans for a bridge as to increase materially the cost thereof; therefore, the expense involved by taking precautions to avoid possible delay would be in the nature of true economy.

In the proportioning of main members of bridges, and even occasionally in the detailing, small economies may be effected by choosing the regular and least expensive sections. Plates and angles are at times cheaper than channels or I-beams, and at other times more expensive. Z-bars are sometimes higher and are always difficult to obtain. Deck beams are invariably high priced, and tees are generally so. Many designers are not aware that I-beams over 15 in. deep cost 0.1 ct. per lb. more than those 15 in. and under in depth, and that angles having one or both legs longer than 6 in. are subject to the same increase. There is a long list of special prices, too, on very small angles. Not infrequently it will be cheaper to use the larger of two small angles, even though more weight be involved; and special angles such as those of 7 by $3\frac{1}{2}$ in. section are always more expensive than the standards, besides being more difficult to obtain. Since the organization of the United States Steel Corporation, the variations in pound prices of the numerous shapes of bridge metal in this country are less than they used to be; but they are still sufficient to make a material difference in the cost of structure; whereas, for Canadian and other foreign work, very large differences may be created by the selection of the material, owing to the variation in the customs duties. It behooves the expert bridge designer to keep posted concerning variations in metal prices and import duties for the different sections. The Bethlehem Steel Co. manufactures, by means of a combination of vertical and horizontal rolls acting simultaneously, some special sections for I-beams that are exceedingly light for their strength; and, although the company asks a small extra price for such sections, it generally proves economical to employ them.

The duplication of a whole structure, or any parts thereof, effects a large proportionate saving in the shop. Of course, if two spans or other units can be made alike, entire groups of drawings are saved; and it is a large part of the function of the detail shop draftsman to duplicate individual parts and to group partially-unlike members. By duplication, in addition to a saving in drawings, there is a saving of templets, a saving of shop supervision, a saving of the writing of shop bills, a saving of making extra material lists, a large saving in errors, and a considerable saving in the field due to the avoidance of loss of time in the selection of the proper parts; for if there is much duplication, there is much more possibility of the right parts being at hand. Duplication extends into very small details; in beam work the end connections are made alike, and instead of being shown on the drawings, their numbers only are given. Likewise the templets for such end connections are made permanent; and they, too, are referred to only by number and are used over and over again. On large structures, batten plates, lattice bars, and other similar and oft-repeated elements can be duplicated with great advantage. For instance, identical lattice-bars save the resetting of the gauge on the lattice-bar punch, and also the labor of selecting in assembling the material, besides considerable expense in handling. It may at times require more material to duplicate the parts of a structure, and yet it may result in a net saving in the cost of construction; for, although the metal be ordered by the pound, if the evidence of duplication of shop work is made clear in the drawings submitted to bidders, a lower pound price will be named.

Blacksmith work of any kind is always the most expensive work in a bridge shop, and it should be avoided to the utmost, not only because it is not commonly well done but also because it costs heavily in the drawing room, in the templet room, in the forge shop, and in punching, fitting, and assembling. If forging is essential, it should be done in duplicate as much as possible, so that dies may be made.

There is a small economy or the reverse involved in the crimping of stiffening angles for plate-girders; and the officers of the different bridge shops have widely varying ideas as to whether it is better or not to crimp them. The economy will depend upon their strength and the amount of offset, for the question involved is whether the cost of crimping the ends does or does not exceed that of furnishing and putting in the filling plates. The cost of the freight on the filling plates is often the determining factor in settling whether it is finally more economic or otherwise to crimp stiffening angles, and this feature of the question should be borne in mind by the designer. This matter of cost of freight and other transportation of metal to bridge site applies to the design of a bridge as a whole as well as to the question of crimping.

There is often a material difference between the lightest possible bridge and the most economic one, not only on account of the reduction of cost of fabrication but also because of that erection; and the designer, in order to obtain the best possible results for all cases, must be well posted on all the important details of both shopwork and field work. He should know almost instinctively what is easy and what is difficult to manufacture and to erect; and especially should he recognize when rivets can and when they cannot be driven by the various kinds of apparatus used in shop and field.

In the design of new bridges to replace old ones, the erection should be given full and thorough consideration, since a large amount of the labor of replacing the old structure under traffic may be saved if the new one have panels of such length as not to interfere with the metalwork of the old bridge. There are many other ways in which advantage may be gained by thoroughly considering the erection at the time the new structure is designed, such, for instance, as the supporting of the old stringers on advantageously located falsework until the new girders can be placed, and the shipping of the plate-girder spans riveted up complete instead of requiring that they be assembled in the field.

In all work of designing, the cost of the materials at the site should be studied very carefully, since local prices will often enable the designer to effect a great saving. Where the work is scattered over a wide field, the matter of cost of materials becomes exceedingly important and often changes the type of the structure. For instance, in designing a highway bridge for the Western Coast, it should be remembered that steel stringers become very costly as compared with the lower-priced wooden stringers of that country. The opposite conditions obtain in the eastern part of the United States. The prices of gravel for concrete work, or of very cheap stone, may affect the type of piers employed. The engineer should know markets even better than the contractor, but commonly he does not, and he will often demand an expensive material where a cheaper one would serve his purpose quite as well. Rough averages of prices per unit in place are very apt to produce flaws in the economy of a design.

There is an economic feature of bridge building that is worthy of special mention, in that it effects a large saving in first cost, maintenance, and repairs, often for a number of years. It is the designing of cantilever brackets to carry in the future wagonways, footwalks, and even street railways, and omitting putting them in until required, but providing all the rivet-holes for the future connections. In such cases, of course, the trusses must be made strong enough to carry the additional live and dead loads, and the counterbracing must be figured for both the future and the immediate dead loads.

A question sometimes arises as to whether it is more economic to support a pavement on buckled plate or on reinforced concrete. The latter is cheaper for trestles and short spans, but not for long ones. However, the deterioration of the buckled plates, due to moisture and smoke fumes, should receive adequate consideration. Moreover, the latest experience shows that very heavy concentrated live loads are liable to spring the buckled plates and break up the paving.

Some Labor Costs of Unloading Building Material with Gravity Conveyors

Gravity conveyors were used extensively for unloading building materials for the construction of the new East Side High School at Cincinnati, O., now being built by the Ferro Concrete Construction Co.

A railroad switch track was built to the building site and most of the material was delivered in carload lots. In all 230 ft. and two curves of Mathews' conveyors were used to unload cement, brick and tile and shorter lengths to unload steel and lumber.

In unloading cement, three sacks were placed on short lengths of 2 in. x 10 in. or 2 in. x 12 in.; about 15 or 20 of these being used to unload a car.

The contents of the car were easily and accurately checked and assorted by using these conveyors and from 15 to 30 per cent was saved as compared to unloading by hand. Labor costs of unloading various materials were as follows:

Construction View at East Side High School, Showing Gravity Conveyors and Portion of Insley Hoisting and Spouting System.

Cement 3 ct. per barrel.
Brick $1.12 per thousand.
4-in. tile $1.00 per thousand.
8-in. tile and larger 78 ct. per thousand.

Financing by American railroad and industrial corporations since Jan. 1, indicated a total of $1,267,898,200, according to the "Journal of Commerce," comparing with $1,617,227,500 in the corresponding period a year ago, a decrease of $349,329,300. Of this total, corporate borrowing operations in August contributed $185,946,000, against $146,336,800 a year ago, an increase of $39,609,200.

The United States Shipping Board has agreed as a result of a recent conference with lumbermen that $40 per M ft. B. M. be paid mills for timbers which will go into the 150 additional ship schedules which the government now requires.

High Speed Cantonment Building

A remarkable record in cantonment building was made at Camp Pike, near Little Rock, Ark., on Aug. 16, 1917, when a 2-story barrack, 43x140 ft., and designed to house 200 soldiers, was erected in 2 hours and 55 minutes. Work was begun at 9 a. m. and at 11:55 a. m. the building was enclosed, floors laid, stairs in place, doors hung and windows fitted in and even screened, roof on, and all scaffolding had been removed and the workmen had left the building. The work was done by James Stewart & Co., Inc., of New York and St. Louis, the contractors in charge of the Camp Pike construction, and moving pictures were taken by Government photographers for purposes of record. The amount of lumber required for this size barrack, of which there are to be over 200 on the reservation, is 75,000 ft. Two hundred carpenters were employed on the work. A notable feature of the construction was the fact that, in spite of the number of workmen and the high speed at which the work was rushed, not a man received a bruise or scratch.

The schedule of completion was as follows: 9 a. m., work started; 9:20, posts and studding up for first story; 9:22, joists started for second floor; 10, second floor outside frame started; 10:20, second floor outside frame finished, first story trim and mill work finished; 10:45, joists on second floor finished; 11, flooring on second floor finished; 11:05, rafters started on roof; 11:30, rafters finished, second-story trim and mill work finished; 11:55, scaffolding removed and workmen out of building.

This Two-Story, 43x140 ft., Barrack Was Erected in Less Than 3 Hours.

Some idea of the way in which cantonment construction is being rushed may be gained, not only from the above illustration, but from the fact that while that particular barracks was being erected thousands of other workmen were busy on at least two hundred other buildings of the 1,600 included in Camp Pike, and other thousands were working on water and sewer lines, etc.

First Building Show in Central Ohio.—A Real Estate and Building Show will be conducted by the Columbus Builders' and Traders' Exchange and the Columbus Real Estate Board at the Ohio State Fair Ground, Jan. 21 to 30, 1918. One entire building has been set aside for the exhibits of concrete mixes, builders' trucks and other heavy contracting machinery, and it is planned to have every phase of the building industry represented. This will be the first building show held in central Ohio. Sam E. Neff, 85 N. High St., Columbus, O., is Secretary.

Preferred Types of Bridges of Illinois State Division of Highways

The Division of Highways of the Department of Public Works and Buildings of the State of Illinois gives preference to the following types of highway bridges for the conditions described:

Concrete Bridges.

For culverts requiring an area of waterway of 12 sq. ft. or less: Plain of reinforced concrete arches or circular culverts, reinforced concrete boxes, reinforced concrete pipe or standard cast iron water pipe.

For culverts having a waterway of more than 12 sq. ft., and for bridges having spans up to 30 ft: Reinforced concrete slabs, plain or reinforced concrete arches.

For bridges having spans of 30 ft. to 65 ft.: Reinforced concrete through or deck girders, plain or reinforced concrete arches.

For bridges having spans greater than 65 ft.: Plain or reinforced concrete arches.

In general, plans for plain or reinforced concrete arches will not be approved unless founded on solid rock or unusually firm hardpan, except for paved culverts and very small paved bridges.

Steel Bridges.

In general, plans for steel bridges will not be approved except for structures spanning drainage ditches, navigable channels, and for locations where the cost of concrete structures would be prohibitive.

For bridges spanning drainage ditches where it is anticipated that it will be necessary to remove the bridge superstructure periodically to permit the passage of a dredge, pin or bolted field connections shall be used.

For bridges having spans of 12 ft. to 45 ft.: Steel I beams.

For bridges having spans of 30 ft. to 100 ft.: Plate girders or riveted pony trusses.

For bridges having spans of 90 ft. to 160 ft.: Riveted trusses with parallel chords.

For bridges having spans of 160 ft. or more: Riveted or pin connected trusses with parallel or inclined upper chords.

Roadways.

In general, clear widths of roadways for bridges shall be provided as follows:

On Designated State Aid Routes: Bridges up to and including 10 ft. in length (not less than a proper shoulder to shoulder width of the road), 20 to 30 ft.

Bridges over 10 ft. and up to and including 60 ft. in length, 18 to 24 ft.

Bridges over 60 ft. in length, 16 to 20 ft.

No bridge, however, when located on a designated state aid route within 25 miles of any city having a population of over 200,000 and on a direct route to such city, shall have a clear roadway of less than 20 ft., or less than 18 ft. when located within 3 miles of a city having a population between 10,000 and 200,000.

On Principally Traveled Roads: On principally traveled roads, other than designated state aid routes:

Bridges and culverts of 10 ft. or less in length, 20 to 30 ft.

Bridges over 10 ft. and up to and including 60 ft. in length, 16 to 20 ft.

Bridges over 60 ft. in length, 16 to 18 ft.

No such bridge or culvert shall, however, when located within 3 miles by direct route of any city or village having a population of 10,000 or over, have a clear roadway of less than 18 ft. for bridges having a length of from 10 to 60 ft.

On Secondary Roads: On lesser traveled or secondary roads:

Bridges or culverts of 10 ft. or less in length, 18 to 24 ft.

Bridges over 10 ft. in length, 16 ft.

Culverts Under Fills: When culverts are built under fills, the length of the barrel of the culvert shall be such as to permit of side slopes of 1½ horizontal to one vertical, and, in addition, a proper top width of fill as follows:

On designated state aid routes, 20 to 30 ft.

On principally traveled roads, 20 to 30 ft.

On secondary roads, 18 to 24 ft.

It is understood that, in case proper provisions for traffic demand, wider roadways may be required.

The New Housing Legislation of California

Three very comprehensive housing laws enacted by the California Legislature become effective Sept. 1, 1917. They are of particular interest as well as important to engineers and architects and others, as their provisions apply to all classes of buildings in which human beings are housed, including the single dwelling house, as well as the hotel and tenement house.

The scope of the laws is not confined to incorporated municipalities. They apply to every part of the State of California, with the exception of the Dwelling House Act which was amended in the legislature so that its provisions would not be applicable to the country districts. However, the other two laws apply in the country districts as well as in the various municipalities. These three laws are believed to be more comprehensive and their scope greater both as to the territory covered and the classes of buildings which come within their purview, than any other set of housing laws in the country.

The provisions of the laws cover more ground than legislation of this character ordinarily does; that is, they go further into the features of construction, specifically fixing the height of wooden, semi-fireproof, and fireproof buildings, as to the number of feet, the number of stories and in ratio to the width of the street upon which they face. They fix the minimum number of fire escapes, smoke towers and stairways; means of egress and the illumination of the same. They provide for the method in which all vent and elevator shafts and chutes must be constructed. They provide that in a tenement house every apartment, and in a hotel every guest room, must have at least two means of egress so that if one egress should be or become blocked the other would ordinarily be available.

Other safety provisions include the fireproofing of steel in fireproof buildings and in semi-fireproof buildings, and that hallways and soffits of stairways in wooden buildings be protected with metal lath and plastered not less than ¾ in. thick, or be protected by similar means.

Privacy and cleanliness has been covered; also sanitary and plumbing conveniences have been gone into quite thoroughly, fixing the minimum number of water closets, slop sinks, kitchen sinks, water faucets and similar conveniences.

Ventilation has been provided for by restricting the percentage of the lot which may be covered by a building and requiring that all rooms have windows opening directly onto a street, a yard or a court. The dimensions of the yards and courts are fixed by the laws in ratio to the height of the building. The sizes of window areas are based in ratio to the superficial floor area of the room they serve.

"Rear tenements" and "rear hotels" are stringently restricted with the idea of discouraging their construction.

The tenement house law covers every building in which three or more families reside and do their cooking upon the premises. The hotel law covers every building, which contains six or more guest rooms which are let or hired out to the public for use as sleeping rooms and includes lodging and rooming houses, public and private clubs, in fact all classes of buildings with the exception of such buildings in which persons are detained under restraint.

The Dwelling House law, whose provisions are not as stringent as the other two laws, takes in every class of building which is not covered by the other two laws, including the single family dwelling.

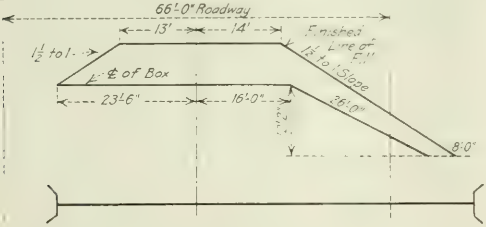
Particularly interesting is the method by which these laws were drafted. The State Commission of Immigration and Housing of California, realizing the necessity of the enactment of housing measures, invited the fourteen largest cities of the State to participate in a State Housing Institute by appointing of official city delegates. The Institute in turn invited architects, engineers, city planners, realty boards, chambers of commerce, hotel and apartment house associations, labor organizations, civic and communal workers, and in fact everyone interested in the subject, to join in the meetings of the Institute to the end that a logical, uniform, practicable and enforceable set of laws might be drafted. All of the cities and the interests affected heartily indorsed the idea and joined in various meetings held in the different parts of the State.

An expert, who was trained in the work of drafting building and housing laws, acted as executive secretary of the Institute and prepared tentative drafts of the bills. These bills were discussed, clause by clause, and made satisfactory to everybody, with the result that all of the cities, as well as the many organizations, including a branch of the American Society of Civil Engineers, the Southern California and San Francisco Chapters of the American Institute of Architects, city planning associations, labor organizations, builders' exchanges and associations, housing departments, building departments, health commissioners and others, unanimously and officially indorsed the bills when they were introduced into legislature.

Mark C. Cohn of Los Angeles has been appointed director of the new bureau, with headquarters in San Francisco. Mr. Cohn was the author, under the Commission, of the tentative drafts of the new State housing laws and has had broad experience in this work, having been chief assistant in the Los Angeles Building Department for over 12 years. He also was a member and secretary of the Los Angeles Building Code Commission for three years, and has served the State as housing and building legislation expert as well as executive secretary for the State Housing Institute.

Method of Handling Excessive Fall on Culvert Construction

Excessive fall between the intake and outlet end of a culvert site is often taken care of by means of a drop inlet box. Another method of handling this problem, developed by Mr. F. G. Mallette, County Engineer of Decatur County, Iowa, is shown in the accompanying illustration. The culvert was constructed on the Jefferson Highway between Davis City and Lamoni. The box is 2 ft. by 3 ft. inside dimensions and contains 32.1 cu. yd. of concrete. The difference in elevation between the upper and lower end is 12 ft. 2 in. The culvert was constructed by day labor, the concrete work costing $14.31 per cubic yard.



Sketch Showing Length and Slope of Culvert.

Culvert on Incline Takes Care of 12 ft. Drop.

Plans are now before the Italian Government for the creation of a new industrial port at Venice. It is proposed to expend $11,580,000 on the project. Preliminary plans and estimates for this work have been approved by the municipality, which will share with the State and with the stock company the expenses of the new port. It is expected governmental sanction will be formally obtained within three or four months.

The 640 Ft. Suspended Span of Quebec Bridge Hoisted to Permanent Position

On Sept. 11, 1916, the center span of the Quebec Bridge, while being raised to position between the cantilever arms, slipped from the hoisting slings and fell into the St. Lawrence River, causing the death of 14 men and a monetary loss of approximately $1,000,000. One year later, using the same methods as proposed for the first attempt, a new span was hoisted and on Thursday last was connected to the anchor arms, thus practically completing one of the great engineering feats of the century.

The actual raising of the new span was started Sept. 17, and on Sept. 20 the required level was reached. The following description of the work is not written from a technical standpoint. It is the newspaper story as it appeared each day in the Montreal Daily Star. It portrays in an unusually interesting manner the various stages of the undertaking:

Quebec, Sept. 17.—. . . . The span, resting on its six coupled pontoons, three at each end, began to rise inch by inch just before 5 a. m. and at 5:43 the work of warping it out to a depth where the waiting tugs could take a hand was begun. This was done by two sets of falls working on anchors, one warping riverward, the other paying out.

At 5:43 the span was out as far as the falls would drive it and the tugs took hold. At 5:53 it was all clear save for one mooring rope on the east end. Then a larger tug backed up to the center of the span and made fast, while at the same time a big tug attached itself to the center on the up-stream side, with a smaller tug at each end. A reserve tug on either side of the span was held ready, in case of emergency, to render assistance.

The tide was running up at 7 miles an hour, and there was a terrific straining on the remaining anchor cable for a few minutes. But the three tugs on the down-stream side were pulling hard against the tide, and holding the mass steady, the remaining anchor cable was cut, and the 5,500 tons of steel had had its last remaining link with Sillery Cove, where it had been born and grown to full estate, severed.

Slowly the flotilla moved upstream, the three tugs on the lower side pulling back until the span was moving at 4 miles an hour, and the three front tugs going slowly ahead with the tide, acting as guides.

On the span itself stood Lieut.-Col. C. N. Monsarrat, chairman of the Quebec Bridge Commission. Phelps Johnson, president of the St. Lawrence Bridge Co.; G. H. Duggan, chief engineer; G. F. Porter, construction engineer; S. P. Mitchell, head consulting engineer, and W. B. Fortune, general superintendent.

Away up on the cantilever arms, reaching out from either shore, stood the crews on whose nerve and skill rested the responsibility of the success or failure of the final steps. On the south shore arm was the assistant engineer, R. W. Burpee, and his men, watching the oncoming mass. With strained attention on the north shore arm was Assistant Engineer Jost and his crew, keyed up to the same tension.

It is safe to say that not one of the men, from the commonest laborer to the highest skilled mechanic, gave a thought to themselves during that seemingly interminable hour that passed while the span was coming towards them. No thought of danger to themselves, nor of the fact that they were all to draw four times their ordinary pay for the work they were doing, entered their heads. They wanted the task successfully completed, and having been painstakingly drilled in every necessary movement day after day, they were fully determined to expend every effort to carry the undertaking through to a brilliant and successful ending. There would be no failure of the human element, if the material element stood the test.

At 7:20 the whistle signals of the tugs brought the span to a stop between the cantilever arms, resting on the scows, the two red and white cones hanging in the center of two wires slung across from one cantilever to the other, being the guides for the operation.

The mooring trusses that hung on either side from the bridge ends had been swung back under the arms to permit of the passage of the span into place, and during the next few minutes, when there was the slack water period of the tide, before it started to ebb, these were lowered and the span was securely moored to them.

Then came the attaching of the hoisting links to the span itself. They were swung forward into the slots prepared for them and securely fastened by a pin—a giant pin made of forged steel, 12 in. in diameter. . . . .

When the hoisting links had all been attached and inspection made that everything was ready for the momentous hoist, there swung out from one of the cantilever arms a traveling crane, and attached to the cable with a huge bucket. This was rapidly lowered to the deck of the scows and all the engineers who had journeyed up on the spar entered it and started off on a journey through the air, being hoisted the 150 ft. from the water level to the track on the cantilever arm, swung inwards and landed just beside the compressed air engines which were so soon to start forcing the water into the hydraulic jacks, and raise the span inch by inch to its final resting place.

The fastenings on the scows had been cast loose and as the tide gradually receded the scows got lower and lower until there was a clear space between their decks and the base work of the span.

The full strain of the 5,500 tons was now on the hoisting links, and there were a few tense moments as the terrific weight hung in suspension. The engineers had no fears for the strength of the apparatus for hoisting—it had been tested piece by piece beforehand and found equal to a strain of over 80 per cent above that which was being put upon it. But just the same, people who knew what was taking place held their breaths, and gave a heartfelt sigh of relief when everything seemed all right.

The scows began to feel the pull of the tide and slowly began to move from under the span. Their task was over—they had done their part—they had borne the mighty burden for the last time—and as they floated clear there was a roar of cheering from shore to shore as if in congratulation to them.

Tugs took them in tow and drew them away from the scene. The great span hung clear a half a dozen feet above the water, the distance gradually increasing as the tide fell.

Then came a wait—to those watching it seemed unending, but in reality it was not much longer than half an hour. The crews who were to work their hardest for the next five hours were fortifying the inner man.

The St. Lawrence Bridge Co. had provided breakfast for the men on the cantilever arms—surely the strangest breakfast table that one could imagine—perched on a mass of iron work, a 150 ft. above the St. Lawrence River, with thousands of people lining the shores on either side and a mass of boats, of all sizes and descriptions, forming a support on either hand. So, while the spectators looked on and wondered what was happening on the bridge, speculating as to the cause of the delay and advancing all sorts of theories to account for it, some optimistic, but mostly of a pessimistic character, the crews were calmly eating a good breakfast.

A signal announced the finish of the repast, and every man sprang to his station like a man-of-war's man aboard his ship. Another signal was given, and the compressed air engines were started, the water wheels were given a turn, and the hydraulic jacks began to move.

In front of the engines was erected a "tell-tale" a double indicator of the height each jack was raising.

This "tell-tale" was built to double scale, so that if one indicator showed itself an inch higher than the other, it means that that side of the span was half an inch higher than the other—half an inch spread over the 88 ft. of the base of the span. Only a mathematician could tell what thousandth fraction of a degree that was out of true level.

In front of each one of the hydraulic jacks there was another double indicator, serving the same purpose, and by regulating the flow of water through the small copper pipes feeding the jacks, the controlling engineers could check any irregular rise on their own side of the span, while the central engineers maintained a similar check on both sets.

As the jacks began to lift, the four men working the hand-screw jacks turned them so as to keep right up with the mounting girder which was hoisting the links, and in case either hydraulic jack went wrong the girder would be held in place, pending repairs.

When the first 2-ft. hoist had been made, the crew manning the checking pin on the lower floor pushed it through a hole in the upright guiding girder, thus locking the link to the cantilever arm. Then the pin in the upper girder was taken out and the jacks lowered—the hoisting link remaining 2 ft. higher than before.

Resuming their normal position, the upper pin was again placed into the hole and another lift was started, the lower pin being removed to allow the hoisting link to be raised. And so it went on, 2 ft. by 2 ft.

Quebec, Sept. 18.—Brilliant sun and not a breath of wind, absolutely "made to order" weather in other words, marks the second day of the great engineering feat of elevating the central span of the Quebec Bridge seven miles up the river. Around the engineers' headquarters, there is a spirit of quiet confidence. You cannot find one of them rash enough to assert that the huge task will positively succeed, but as the hours pass hoist succeeds hoist, each one a little faster than its predecessor, and as the mighty mass of the span creeps upward, every man upon whose shoulders rests however small of weight of responsibility breathes just so much easier.

Dawn disclosed the span swinging securely at the end of the links. Last night it was made doubly sure from interference from wind by heavy cables to the mooring trusses, but there was scarcely a breath during the night.

The rising sun was the signal for the sudden upspringing of a heavy mist, which clung obstinately to the river gorge, leaving the heights on each side bathed in sunshine. The great cantilever arms vanished into dense banks of gently swaying fleece, out of which came the steady breathing of the hydraulic jacks and the occasional ring of metal on metal. One of the most impressive things about this most impressive business is the almost total silence in which it is being carried out.

Yesterday, although the majority of people watching from the shores—and there were nearly fifty thousand holiday-makers spread along both banks during the day—calculated that fourteen lifts had been made, as a matter of fact there were only twelve. When the crews stopped for breakfast they left the hydraulic jacks at the top of the upward stroke, and when they resumed half an hour later, and the jacks were lowered, people thought it was another lift. The same thing happened in the afternoon, when there was an interval of three hours to allow of the fixing of the tackle for removing the links from the top of the upper jacking girder as they are pulled up.

The official report of the day's proceedings showed that prior to the attaching of the span to the hoisting links the latter were lowered another 2 ft., making the total height to be hoisted 152 ft. in all. The first hoist was commenced at 9:10, while the span was still on the scows. Three hoists were made in succession, being completed at 10:28. Then the crews were given lunch on the bridge. The fourth lift started at 2:05 p. m. and was completed at 2:22, taking seventeen minutes to complete the operation.

The times for the other hoists were as follows: Fifth hoist, 2:23-2:39, time 16 minutes. Sixth, 2:39-2:55, 16 minutes. Seventh, 2:57-3:15, 18 minutes. Eighth, 3:15-3:32, 17 minutes. Ninth, 3:33-3:50, 17 minutes Tenth, 3:51-4:08, 17 minutes. Eleventh, 4:09-4:25, 16 minutes. Twelfth, 4:25-4:40, 15 minutes.

It will be seen from this table that in the late afternoon the men made the best time, doing the last five lifts in a fraction over sixteen minutes each—which was considered by the engineers to be remarkably good, and nearly four minutes better than they had calculated as a fair average, allowing for adjustments. The compressed air pumps were operated at the rate of 45 to 50 strokes per minute.

Last night the mooring lines were removed and strong anchoring tackle was put on to hold the span in place against any wind that might spring up in the night.

After the first two hoists of this morning, which were completed at 8 o'clock, an hour and a half was spent in removing the first section of the hoisting links at each corner. These links are 24 ft. long, and as they are pushed upward they project above the cantilever arms and are easily removed.

At a quarter to nine a thick mist blew down the river, hiding the bridge almost completely for a short time, but the strong sun soon dispelled it, and by the time the first train of sightseers arrived about half-past nine, everything was bright and clear and people could watch the slow rise and fall of the jacks.

Ten thousand people came out to the bridgehead by the Canadian Government Railway and were kept by Capt. Scroope, head of the St. Lawrence Bridge Co. special police, and his men, clear of the bridge approaches.

About 10 o'clock the sun sucked the resistance out of the fog and from the cliffs the observers could note progress. The highest point of the span then hung apparently about 25 ft. below the deck level of the cantilever arms. By noon this gap had been bridged and when lunch was served the topmost point on the curving arc of the swinging span was, as nearly as could be judged, at deck level. There were then 38 ft. more to go before deck joins deck.

Reference has been made to precautionary measures being taken to avoid accident. One of these is scarcely scientific, but is none the less potent with the men on the ends of the cantilever arms. There is no hoist number 13; they jump from 12 to 14 via 12 A.

The way the men on the steel look at it is that while there may be nothing in that old 13 stuff, on the other hand there may be. Therefore, to eliminate it is possibly on a par with installing a few extra hand jacks, and leaving the mooring trust hanging instead of taking it down, as they did last year—a little "safety first" measure that doesn't cost much and may mean a lot.

They made 14 hoists this morning, or more than they made all day yesterday. Furthermore, they made three of them in 12 minutes each, beating the best record yesterday by about three minutes.

Work will be stopped about 5 this afternoon, as it was yesterday. It is, of course, impossible to predict with certainty, but the span should be in position some time tomorrow afternoon.

Quebec, Sept. 19.—The bridge job is half over. At 9:55 this morning the hydraulic jacks eased off on the hoist that marked the middle of the great task of raising the center span. The men doing the work may have noted the point, but if they did they said nothing. Incidents of that character make little impression on them.

Work is proceeding with the perfect smoothness that suggests endless rehearsal. It is as though men on the ends of the cantilevers had been putting up this particular bridge all their lives. There have been one or two slight delays, but not one serious hitch. The total accidents have been a broken nose when a bit of broken bracket fell, and a few bruises through a slip on a wet plate. But lest there should be any suspicion of rushing, a fiat went forth that no hoist should be completed in less than fourteen minutes. Yesterday they clipped some of them off in twelve.

When the gangs knocked off for lunch, the span almost hid the highest point of the south shore cantilever from the deck level of the north side. If things continue to go as smoothly today and tomorrow as they have since the commencement, the span should be in position by tomorrow evening. Weather conditions are still perfect, the expected blow predicted by the weather experts having failed to materialize. There is a gentle west wind which merely tempers the sun. At 12 o'clock three-fifths of the hoisting was completed.

Three hours were lost yesterday through the breaking of a brackett used for lifting out the link sections after they have been hoisted—a petty mishap, which had nothing to do with the actual span lifting, but—it was enough to hold up all the work and prevented the span from being raised beyond the half-way mark as it otherwise would have been.

So this morning the engineers spent the first two hours in overhauling and bracing the brackets on every section, believing it wiser to strengthen them now rather than be held up later on in the day.

The tuning up of the compressed air engines and the team work of the crews at each pin, resulted in a record being established yesterday afternoon for a complete cycle—that is, a hoist and a lowering of the jack. It only took eleven minutes to carry out, which is an improvement of several minutes on the first day's work.

The official record of yesterday afternoon's hoists were as follows:

Twenty-seventh hoist commenced at 3:36, finished at 4:00, time 24 minutes; twenty-eighth, 4:00½-4:12, 11½ minutes; twenty-ninth, 4:13½-4:26½, 13 minutes; thirtieth, 4:27-4:39, 12 minutes; thirty-first, 4:10-4:52, 12 minutes; thirty-second, 4:53-5:06½, 13½ minutes; thirty-third, 5:07-5:19, 12 minutes; thirty-fourth, 5:20-5:31, 11 minutes.

This morning's official figures follow:

No.	Started.	Finished.	Time mins.
35	9:03	9:17½	14½
36	9:17½	9:33	15½
37	9:33	9:49	16
38	9:49	10:03	14
39	10.03½	10.25	21½
40	10:44	10:58	14
41	10:58	11.14	16
42	11:14	11:28	14
43	11:28	11:42	14
44	11:42	12:01	19

Quebec, Sept. 20.—A cold, gusty wind, which at times reached 25 miles an hour, marked the first break in the perfect weather which has from the beginning aided in the big task at the Quebec bridge. It was doubtful, early in the morning, whether work would be commenced, but there was a thorough inspection and the engineers decided to go ahead.

As though in reward for their courage, the wind dropped to 22 miles, and better progress than ever was made with the hoists. In less than an hour four of them were made. The wind was blowing in gusts which traveled with increased force down the river gorge, but the span showed no sign whatever of any strain upon it.

With only 15 more hoists to make, the great span entered on the home stretch at 9 o'clock, when hoisting began. Barring accidents, the setting of today's sun should see the coupling pins clenching deck to deck and the four steel and concrete highways flung across a hundred and fifty feet above the river finally linked up.

Yesterday passed without incident, a day of steady, calculated progress, while the curve of the span rose like a top of a great steel moon between the outstretched arms. It was a day of rather depressing weather, hot, with a steadily falling barometer. A spatter of rain came a little after four and passed, but the big men on the job had eyes only for the barometer needles.

What looked as though it were going to be a very ugly storm blew up just before six, with careering clouds. It was split as though with a great knife just before it struck the bridge and went flaring and growling off east and west. The engineers were serene enough, however. It would have taken a mighty storm to effect the span now so closely hauled up on its hoisting chains.

At 2:19 p. m. the final lift was completed. After this the pins which will bolt the span to the cantilever arms alone remain to be inserted to complete this portion of the work.

Problems in the Sanitation and Ventilation of Textile Mills

The problems of sanitation and ventilation in industrial plants have not until recently received that thorough attention which is properly due them through their close connection with the health and efficiency of the workers. An interesting discussion of these problems was presented on Sept. 13 before the congress of the National Safety Council by Mr. W. Fred Dolke, Jr., of Lockwood, Green & Co., Engineers, Boston, Mass. An abstract of Mr. Dolke's paper follows:

In any installation of toilet facilities in a mill the main considerations to be studied will be the location and housing of the toilet rooms, and the amount and kind of equipment.

With regard to the location of the toilet facilities there are two prominent features to be considered. In the first place, facilities should be so placed that there will be no undue loss of time because of their remoteness from any worker. This is a matter which must be studied out for any individual plant, but practice and law have established definite limits. Massachusetts, for example, has set 300 ft. as the maximum distance except in those cases where service elevators are provided for employes. New York State requires that no water-closet shall be more than one floor above or below the regular place of work of a person using the same, and recommends that toilet rooms be placed on the same floor with the workers even at the expense of installing a larger number of rooms.

The second consideration in the location of the toilet room is one which under the enlightenment of modern thought is so obviously desirable as hardly to need mention. It is that toilet fixtures should be located in rooms entirely separated from the workshops. The advantages from the point of view of health and decency are self-evident, but it is a sad commentary on human character that the various states find it necessary to make separate housing of toilet facilities a legal requirement.

Of course it is sometimes desirable to place washing facilities directly in the workshops, but it would seem preferable generally to install them in the toilet room. When locker rooms are provided it is decidedly advantageous to locate the lavatories with the lockers, with the other toilet fixtures in an adjoining room. In this case there should be direct access from the workroom to the toilet room so as to prevent employes from lingering at their lockers, and also at least one lavatory should be located with the water closets.

The size of the toilet rooms will naturally depend upon the number of fixtures to be housed, but even in this case the minimum requirements have been set forth in some states by legislation and these requirements constitute a good working basis. In New York state it is necessary to provide at least 90 cu. ft. for each water closet or urinal, while Massachusetts stipulates 10 sq. feet and 80 cu. ft. as the minimum space allowable.

When we turn to a consideration of some of the problems of ventilation in textile mills, we take up a subject which not only tends to be complex, but one which has a more direct and obvious effect on health.

Because we know the amount of air which is taken in by an average adult at each respiration and also the results in air change at each respiration, we are able to compute that we must supply to each individual in a room 2,000 cu. ft. per hour of fresh air containing four parts of carbon dioxide in 10,000 in order to maintain a carbon dioxide content in the room of not over seven parts.

It is evident that where there is a space of 2,000 cu. ft. for each person in a room with all doors and windows tightly closed, it will take an hour to raise the carbon dioxide content to the danger point, and also that if any positive movement of air in through the windows takes place the length of time required to raise the carbon dioxide content to the danger point will vary according to the amount and quality of incoming air. With less than 2,000 cu. ft. of space per person in the room, some means of ventilation will evidently become necessary.

This matter is rapidly becoming the subject of state legislation and a statement of the requirements of the Illinois ventilation law for factories and mills will interest us as giving some basis for determining when ventilation becomes necessary.

This law requires at least 500 cu. ft. of space for each person in rooms using lights that consume oxygen and at least 250 cu. ft. for rooms using electric lights. In addition it is stated that all rooms having at least 2,000 cu. ft. of space per person and having an outside door and window area of at least one-eighth of the floor space shall not be required to have artificial means of ventilation.

All rooms having less than 2,000 cu. ft. of space per person and with an outside door and window area as before specified must be provided with an artificial means of ventilation at the rate of 1,500 cu. ft. of fresh air per person per hour during such weather when windows can not be left open for ventilation. When the outside window and door area is less than one-eighth of the floor space then artificial ventilation must be supplied at the rate of 1,800 cu. ft. per person per hour.

This law does not seem logical or consistent, but that is not a point to be argued here. Other states, notably Ohio, New York, and Massachusetts, have laws for ventilation which are not so specific.

Now, what are the conditions in textile mills? In spinning rooms, employes occupy from 500 to 1,000 sq. ft. of floor space, and so, for usual story heights, from 5,000 up to as much as 12,000 cu. ft. of space, per employe. The window openings will vary from as little as one-fifteenth to as high as one-sixth in unusual cases. The average will probably be about one-tenth. Weave-shed workers will occupy about the same amount of floor space in general as that given for spinning employes, whereas the cubic space will be even greater. Not all weave sheds are well supplied with windows, but the ventilators usually placed in the peak of the sawtooth skylights will act in the place of windows.

In most modern textile plants the relative humidity is kept at or near a constant point by artificial apparatus for manufacturing reasons, and it thus becomes necessary to maintain the temperature of the workrooms at that point in relation to the humidity which will result in the greatest comfort to the employes; in other words, to provide only so much external heat as is necessary to prevent the body radiating more heat than it produces.

Unquestionably the only certain and efficient method of securing proper renewal, proper circulation, and proper conditioning of air under all circumstances is to force fresh air that has been washed, heated, and humidified, into the room under pressure. It is not my intention to say that natural ventilation is always a failure, but to bring out the self-evident fact that to maintain a standard atmospheric condition in a room, that room must be considered a closed box and air of a definite condition admitted.

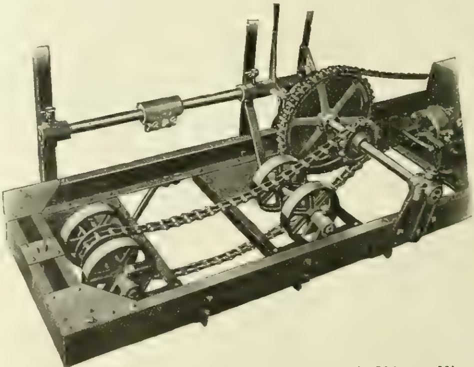
A blower system of heating and ventilation has many advantages, briefly outlined as follows:

Positive ventilation is obtained entirely independent of changing climatic conditions. The air can be washed free of all dust, and the humidifying which is necessary in textile operations can be done at the heating and blowing apparatus. A much smaller amount of radiating surface will be required in the workroom to perform an equal heating duty with a consequent reduction in the number of steam-tight joints, unions, and valves to keep in repair. The air leakage being mostly outward the building will be freer from drafts and more uniformly heated. The system is easily regulated to respond readily to changing outside temperatures. In summer the air may be cooled by the circulation of cold water through the heater, while simply running the fan will in itself greatly relieve the oppressiveness of hot, sultry weather.

The biggest objection raised against a blower system is its much greater initial cost and the amount of power consumed in running the fan and in heating outside air. This objection can be offset in part by a lower maintenance cost, and largely by the great advantages that accrue both to the employes by reason of better working conditions and to the employer from greater efficiency of the workers and better quality of product.

Concrete Mixer with Underslung Chain Drive

A concrete mixer with underslung chain drive has been placed in production by the T. L. Smith Co., Milwaukee, Wis. In this design the chain goes under the truck frame, around an idler pulley on the roller shaft and back under the drum, the latter serving as a constant and automatic tightener. It is claimed the upward pull on the chain produces a perfect contact between the chain and the sprocket teeth, and also materially reduces the wear on the rollers, roller shafts and boxes. The new 7-S Smith-Chicago Mixer is equipped with this drive.


Underslung Chain Drive Arrangement of 7-S Smith-Chicago Mixer.

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Why the Bad Stretches in State Highways Are Often Found in Cities and Villages

In an address before the League of California Municipalities, Mr. Charles F. Stern, State Highway Commissioner, said:

> If the traveler through your town is a through traveler, all he will note is that it is a place in the road where he drops from a concrete pavement to a rough piece of going.

What is true of California in this respect is unfortunately true of every other state. Paved state highways are marred by ill paved or unpaved stretches through cities and villages. There is almost complete lack of co-operation between state and municipal officials. Why? Principally, not because there is either absence of desire to work in harmony toward securing continuous, smooth highways, but because municipal authorities are usually powerless to co-operate. We suggest that city engineers should initiate movements leading toward reforms in city ordinances and even in city charters, with a view to giving the city engineer powers similar to those possessed by a state highway commissioner and its engineers. A state highway commission has authority to build highways where, when and how it wishes to build, is not circumscribed and harried by foolish laws, and can spend monies so as to secure the greatest benefit for the greatest number in the state. In most cities and towns no one possesses any such authority as to street improvement. Hence the crazy-quilt streets that characterize most of our municipalities.

A Common Fallacy in Estimating the Economy of Different Classes of Highway Bonds

It is frequently asserted that "serial bonds" are more economic than "sinking fund bonds" for public works, and hypothetical calculations are produced that seemingly prove the proposition. We will indicate briefly the fallacy involved in such reasoning.

A sinking fund bond is one that is redeemed at the end of its life by the payment of a sinking fund that has been built up from the deposit of annuities that draw compound interest. Serial bonds, on the other hand, are not retired by means of a sinking fund, but certain amounts of the bonds are retired annually until the entire series has been paid off. To illustrate, if $100,000 worth of 4 per cent 20-year sinking fund bonds are issued, and if the sinking fund draws 3.5 per cent interest, the annual interest is $4,000 and the sinking fund annuity is $3,536, making a total "annual cost" of $7,536. If $100,000 worth of 3 per cent serial bonds are issued, and one-twentieth of them matures each year, the "average annual cost" is $7,100. This gives an apparent economic advantage of $436 annually as compared with the sinking fund bond. We say apparent, for there is no real economic advantage whatsoever.

In solving any economic problems of this sort, it is essential not only to look at the expense side of the account but also at the income side. Engineers and political economists are given to forgetting the income side of the account, and thus fall into the error of believing that by merely changing the dates of payments on loans they can change the profits of an enterprise. Let us now consider the net income derived from the expenditure of the $100,000 principal.

Let us assume that the $100,000 is invested in a country road, and that as a result of the road improvement a net saving of $10,000 is annually effected in the cost of hauling produce over the road. Now, if this road were the property of a company, and if the company hauled all the products and charged a given rate per ton-mile, it would follow that, since the improved road caused a net saving of $10,000 annually, the annual net earnings of the company would be increased by $10,000. On the other side of the ledger would appear an interest charge of $4,000 on the $100,000 bonds, leaving a net profit of $6,000 attributable to the road improvement.

Out of this $6,000 annual profit is to come the money with which to redeem the bonds. If the bonds are 20-year sinking fund bonds, then an annuity of $3,536 will serve to redeem them, according to the assumed conditions above given. Deducting this from the $6,000 annual profit leaves $2,464 surplus. But, if the bonds are 20-year 4 per cent serial bonds, the first annual payment will be $4,000 interest plus $5,000 to retire one-twentieth of the bonds, leaving a balance of $1,000 to be put in the surplus. The next year, however, the amount placed in the surplus would be $1,200, and for each succeeding year the increase in the annual amount placed in the surplus would be $200.

Now, if the company invests the surplus in securities bearing 3.5 per cent interest, at the end of 20 years the surplus will be precisely the same in both cases. In other words, at the end of the life of the bonds the company will be precisely as well off financially whichever form of bonds it issues, whether serial or sinking fund. Of course, if the surplus is assumed to earn no interest, then the serial bonds are preferable; but this is an assumption that is not tenable, for under the very assumption that a sinking fund will yield 3.5 per cent it is admitted that all capital can find that rate of return.

What is true of a company, such as we have pictured, is true of a community—a county, a city or a state—but the fact is obscured because the profits resulting from highway improvement are never gathered into one surplus. Instead, the profits flow into many different coffers, whence the different individuals draw them for private investment or consumption, each according to his pleasure. This, however, does not alter the fundamental economic likeness of the hypothetical company and the actual community.

We have discussed this problem at some length because every year several engineering articles are published in which the authors endeavor to show that a given method of paying off highway bonds is more economic than some other method, when, as a matter of fact, there is no economic gain whatsoever. The errors in such reasoning always may be traced to failure on the part of the authors to consider the income side of the account. They look through the hole in the doughnut without seeing the doughnut.

Cost Keeping on All Roadwork in Washington State to Be Made Compulsory

A bill is before the legislature of the state of Washington providing for a system of cost records on all state and county roads. The bill is so unique that we have published it in full in this issue, as part of a paper by David H. White, entitled "Report of Joint Committee on Cost Data for Construction and Maintenance of Roads."

It is our judgment that this bill is essentially sound in principle, for it aims to secure records by which it will be possible to determine not only the efficiency of engineers and road builders, but the relative worth of different types of roads under stated conditions. Also it will be seen that the bill provides for a uniform system of cost records throughout the state, thus making it possible to compare the unit costs incurred by the different counties.

In carrying out the provisions of this bill, should it become a law, it will be desirable to require the measurement of all quantities of different classes. Where work is done by contract, it is customary to measure quantities in order to determine the contractor's compensation, but where work is done by day labor it frequently happens now that quantities are not measured.

One of the main objects of this bill is to ascertain unit costs, whether the work is done by day labor or by contract. There can be no doubt that if this object is accomplished, much greater economy will be effected in both road construction and maintenance than would be possible otherwise.

According to figures reported to G. F. Loughlin, of the U. S. Geological Survey, there were sold in 1916 44,795,796 granite paving blocks, valued at $2,288,486.

An Unusual Advertising Campaign by Engineering Colleges

On the opposite page we reproduce an advertisement that is appearing in daily papers throughout America. It will be noted that it is sponsored by 56 engineering colleges, or about half the total number in this country. Relatively few names of State universities appear in the list, but all the other leading universities have co-operated in this laudable enterprise.

Early this year Engineering and Contracting began urging a publicity campaign of this sort, for it was evident that America's entrance into the world war would reduce the attendance at engineering colleges unless special efforts were made to induce young men to secure technical training.

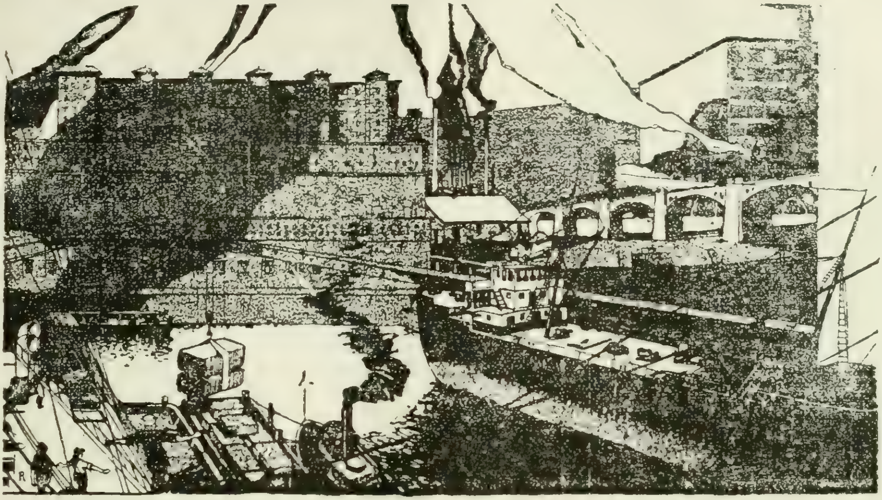
Although this co-operative advertising has started somewhat late in the season, it will doubtless bring results. There are engineers who will criticise this attempt to increase the number of engineers, and it will be urged that no dearth of engineers exists or is likely to exist as a result of the war. Also it will be said that general advertisements like that on the opposite page will lead many an ill-adapted man to enter the engineering profession.

Debate as to whether or not more engineers will be needed should not be allowed to begin until the debaters have defined the term engineer and have agreed upon the general scope of engineering. When that is done there is likely to be no debate.

Engineers who still adhere to the narrow conception of engineering as being merely the designing of machines and structures, would have some reason, perhaps, for believing that a sufficient number of students are annually graduated from engineering colleges. They may well dwell upon such facts as the consolidation of many public utility and manufacturing companies and the standardization of plans, as being economic steps that tend to reduce the number of designers needed in this country. But the engineer who has a broader conception of what his profession embraces will at once refuse to debate if he is to be held to a narrow definition of engineering. To him anyone who applies science in the solution of economic problems is doing engineering work, and if he trains himself or is trained to do so systematically upon every occasion, he is entitled to be called an engineer.

There is an infinitude of ways in which science may be applied, and engineering already offers a vast number of fields for the application. Therefore, even though many an engineering graduate lacks the qualities that go to make an "ideal" engineer still his engineering education makes him of more worth to himself and to society than would be the case were he wholly untrained in science. In any event, the risk of influencing undesirable or unfit men to study engineering should not be used as an argument against general publicity as to the value of engineering education.

During the 22 years from 1895 to 1916 only 35,777 engineers of all kinds were graduated in America, 11,621 being civil engineers. Engineers who have been accustomed to speak of the overcrowded condition of the profession may well ponder these figures. If in a nation of a hundred million people, 11,621 civil engineers graduated in 22 years can cause an overcrowding, then civil engineering is not the increasingly important profession that we have believed it to be.



After the War

THE wheels of industry must turn again. Railroads, highways, factories, ships and even cities must be built, here and abroad. Mines must be re-opened. The conditions of a war-torn world must be met.

America must take a leading part in the reconstruction to come. We need to prepare for this work as we do for the war. Products of our factories, farms and mines, raw materials and finished products will be needed in enormous quantities. The wounded must be aided and sanitation restored. Navigation must be supplied for our new commerce.

To do this work we need the services of a vast number of trained engineers, chemists, biologists, metallurgists, agriculturists and physicians. The supply of trained men must be increased to meet this overwhelming demand.

Young men who are ineligible for military service, for one reason or another, or who can render better service by completing their technical courses should train themselves for work in the field of applied science. It is your duty! You owe it to your Country in justice to the men who are going to the front.

Shot and shell have reduced the ranks of European engineers. And the war needs of America have lowered our number of available engineers. Many European technical schools have closed or have but few students. *We* must meet the world's needs with technically trained men.

The field of applied science offers an unequalled opportunity for young men fitted by nature to embrace it.

Men at the head of our Government realize that the great need for technically trained men is becoming even *greater*. Read their actual words. Let them point out your duty. The need is acute.

Read These Messages

President Wilson

"There will be need for a larger number of persons expert in the various fields of applied science than ever before. Such persons will be needed both during the war and after its close. . . . . . I would particularly urge upon the young people who are leaving our high schools that as many of them as can do so avail themselves this year of the opportunities offered by the colleges and technical schools, to the end that the country may not lack an adequate supply of trained men and women."

Secretary of War Baker

"Let the young men of America devote themselves to the various branches of engineering education, so that when this war is over the call will not be in vain to young men who have had the training and have learned the lessons necessary to enable them quickly and rapidly to play a part in that great reconstruction enterprise."

General Wm. M. Black
Chief of Engineers, U. S. Army

"This cataclysm of war must not be allowed to disorganize our structure for all time, and one of the things we will need after the war, just as we have needed it before the war, just as we are needing it today, will be trained young men to take the place of the older who go out."

Major-General Leonard Wood

"Boys should remember that they are now serving in the best possible way by preparing themselves to serve more efficiently when the time comes . . . It is a great mistake for partly educated young boys to rush to the colors now. We don't need them. It is very important they should finish their education."

Colonel S. E. Tillman,
Supt. West Point Military Academy

"Only the most urgent conditions should withdraw any boy from school. In justice to the Government as well as to themselves they should finish their courses."

Brooklyn Polytechnic Institute
Brown University
Carnegie Institute of Technology
Case School of Applied Science
Clarkson College of Technology
University of Colorado
Columbia University
Thayer School Civil Engineering, Dartmouth
Drexel Institute
George Washington University
Harvard University
University of Illinois
Johns Hopkins University
Lafayette College
Lehigh University
Leland Stanford, Jr. University
Massachusetts Institute of Technology
University of Michigan
Michigan Agricultural College
Michigan College of Mines
Missouri School of Mines
University of Missouri
New York University
University of Pittsburgh
Towne Scientific School, U. of Penn.
Princeton University
Rensselaer Polytechnic Institute
Rose Polytechnic Institute
Rutgers College
Sheffield Scientific School, Yale
University of South Dakota
Stevens Institute of Technology
Syracuse University
University of Tennessee
University of Texas
Tufts College
University of Vermont
University of Virginia
Washington University, (St. Louis, Mo.)
University of Wisconsin
Worcester Polytechnic Institute

The "Unit Cost Plus a Fee" Contract

We outlined in our last Roads and Streets Monthly issue, Sept. 5, a novel form of contract that is now being used on some of the state highway jobs in Massachusetts. The contractor is paid the actual cost of the work plus an agreed price per unit of work done, this price being the contractor's fee. The fee covers the contractor's services and the use of small tools, a rental price being paid for other equipment.

On one contract the contractor's fee for earth excavation was 6 ct. per cu. yd., and 12 ct. per ton for broken stone. This would indicate a fee approximating 10 per cent of the cost of the work.

For certain classes of work this form of fee contract has advantages over the "cost plus a fixed sum" contract. For one thing, it permits any desired extension or curtailment of the work.

Emergency Road Improvement to Relieve Railway Congestion

Manufacturers have repeatedly been forced to transport materials and products long distances over bad roads because of railway congestion. In order to relieve this condition a meeting was recently held in Detroit to discuss what may be called emergency road improvement, with a view to facilitating the use of motor trucks.

Representatives of the Office of Public Roads and of six state highway commissions, Captain Galbraith, William Inglis and R. C. Hargreaves discussed the transportation of products by motor trucks at industrial centers and port terminals. As an object lesson in unpreparedness a very bad 9-mile stretch of the Detroit-Toledo road was mentioned. In reply to a request the governor of Michigan wired that he would take steps to put this piece of road in first class condition as soon as possible.

In and near other industrial centers there are many streets and roads that should be improved without delay; in fact, much of this work should be classed with emergency construction rendered necessary by war conditions.

Steel Prices Cut in Two

An agreement between the War Industrial Board and the steel men has resulted in cutting steel prices in two. The following are to be the prices until Jan. 1, 1918, at Pittsburgh and Chicago:

	Price, cts.	Reduction. per cent.
Bars	2.90	47.3
Shapes	3.00	50.0
Plates	3.25	70.5

The price of pig iron has been lowered to $33 per gross ton, a reduction of 43 per cent below the recent price.

The War Industries Board is to supervise the distribution of the output of the steel mills, and will, of course, give precedence to government requirements and war order. The mill owners have agreed to make every effort to meet the extraordinary demand for their products.

A road building regiment is now being recruited for service in France. It will be composed of experienced road builders, laborers, quarrymen and foremen and engineers.

Causes of Failure of Highway Contractors

Interesting information on the causes of failure of contractors engaging in State highway construction was given by Mr. Walter C. Howe, Division Engineer of the State Highway Commission of California, in a recent address before the San Francisco Association of Members of the American Society of Civil Engineers.

At the beginning of the State highway work in California, stated Mr. Howe, contractors of all types and classes rushed into the field. Many mushroom firms lacking both experience and financial backing, bid for the work, and, in consequence, the earlier contracts were a source of considerable trial and tribulation to the engineers of the Commission. As was to be expected, a large percentage of these contractors failed, leaving many outstanding unpaid obligations. The general basis on which contracts were drawn, and the obligations assumed by the contractor, were similar to the general requirements on all first-class engineering works, and as every clause was set down in the specifications contractors were, or should have been fully cognizant of the requirements before placing bids.

The following concrete examples of the cause of failures were cited by Mr. Howe:

On a certain mountain grading job on the Coast Route, eight of the contracting firms bidding on the work submitted bids below the engineers' estimate. For argument it might be said that perhaps the engineers were in error and their estimates too high. As a matter of fact, and in the light of subsequent events, the engineers' estimates were very conservative. The estimate on this grade was made up after a careful and thorough study of the country and conditions, and it is to be presumed that an estimate made under such conditions would more nearly approximate the final cost of the work, than would an estimate made by a contractor after making only one casual trip over the line. Yet many of the bids submitted by the contractors were made up after a very hurried trip over the mountain with only a few hours' study. The successful bidder underbid the engineers' estimate some $21,000 on a $70,000 job, and although given opportunity by the Commission to withdraw his bid, he insisted upon the award of contract, filed necessary surety bonds and proceeded with the work. In addition to this handicap, the contractor had never before attempted a piece of formidable mountain grading work, his efforts having been directed particularly along the lines of minor paving jobs. Of course, failure stared this contractor in the face from the very outset, and the final outcome was disastrous, the Commission finishing the work with a day labor organization.

A second failure of some importance occurred through lack of foresight on the part of contractors to investigate the country in which the contract lay sufficiently in advance of their bid, to insure a proper and adequate supply of coarse and fine aggregate. In consequence they were compelled to haul materials for long distances and were subjected to vexatious delays in railroad transit.

On a concrete highway only those contractors who keep their materials of construction moving on schedule, their pumps and water line in first-class operating order, their concrete mixer and mixer crews working full time for 5 or 6 days in the week, can hope to complete their contract at a profit.

The firm in question was unable to do this. The concrete mixer crews were demoralized, the mixer was shut down two-thirds of the time, and the result was inefficiency, chaos and financial loss.

The rank and file of an organization make for its success or failure, yet inexperienced superintendents or foremen with little or no flexibility of judgment, are often employed by contractors. For example, one superintendent on a contract which entailed hauling 25,000 to 30,000 tons of material, maintained an organization of several worn-out motor trucks and his hauling cost, starting at 45 ct. per ton mile, gradually increased during the progress of the work. When an attempt was made to show this superintendent the extent of his loss, he airily dismissed the subject, resented the friendly criticism and continued to use the trucks.

To lay concrete economically, and that means with considerable speed, there is every need for an experienced crew of "huskies." A crew of men trained in this work and physically strong at high wages, viz. $3 to $3.25 per day, can lay concrete at a cheaper cost than untrained and inexperienced men at the low wage of $2.25 per day. This has been demonstrated on the State work time and time again, and yet many of the contractors continue to organize their concrete paving crews from hobo labor drifting by.

In general it may be said that the experienced old line contractors with their skilled working organizations and complete grading and paving outfits, seldom submit other than conservative bids. It is true that these experienced firms have sometimes suffered losses on highway work, but there have been few, if any, failures. It is to be expected that the contracting firm owning its own steam rollers, concrete mixers, pumps, engines and water lines, its dump wagons, scrapers and graders and its stable and commissary outfits, is in a better position to complete a job at a profit, than the contractor who attempts to rent all of his outfit and build up a grading and paving organization in a week.

As an example of how some contractors made a profit even under a close bid, Mr. Howe cited the following:

In October, 1914, a contract was let by the State for grading the Cuesta Grade in San Luis Obispo County. The contractors' bid closely approximated the engineer's estimate. The successful bidder was a contractor skilled in heavy grading work. As the contract was let very late in the year, the engineer was dubious of the successful prosecution of the contract at a profit. Visions of steam shovels, wheelers, fresnos and stock stuck in the mud or tied up by winter rains and slides were uppermost in the minds of those who knew the country. This contractor, however, proved himself a man of sound judgment, fully able to cope with a heavy grading job in the dead of winter. He shipped a small outfit to the work and a few head of stock. He disappeared for a few weeks ostensibly to ship a steam shovel. Instead he returned with a large number of Swede, Slavonian and Greek station men, who sub-contracted to do pick and shovel work between certain stations. These station gangs worked practically through the entire winter despite the fact that the seasonal rainfall was 32 in. The work was well and satisfactorily performed. The good judgment of the contractor in substituting station men in winter for steam shovels and stock, also his ability to drive a shrewd bargain with these station men, resulted in the work being completed within the time limit and at a snug little profit.

Roller Method of Finishing Concrete Roads as Used by Vermilion County, Illinois

By P. C. McARDLE,

Superintending Engineer, Bond Issue Roads of Vermilion County, Illinois.

The elimination of the excessive water which it is necessary to use in mixing and placing concrete roads, and the compacting of the surface, have claimed the attention of all engaged in this class of construction, especially engineers. Henry W. Bowlby, former State Engineer, State of Oregon, invented, patented and successfully used a roller of the contour of the road operated by a gas engine running on the side forms. Captain J. J. Gaillard, City Engineer Macon, Ga., uses a small hand roller of dimensions unknown to the writer. City Engineer Johnston of Sioux City, Ia., uses dry sand cement mortar worked in by hand floats. These devices are employed for the purpose of removing excess water from the concrete and compacting the surface.

Repeated laboratory tests made by the writer and others have proved beyond question that excess water weakens concrete, particularly in the early periods, in both tensile and compressive strength in proportion to the excess of water used. There can be little doubt that excessive water leaves concrete porous and tends to produce excessive shrinkage in warm or windy weather. The matter was the frequent subject of discussion between Mr. A. Kaufman of the Portland Cement Association and the writer. Both sought a remedy, if possible an inexpensive one, that could be tried out on our county bond roads, contracts for which had been let and for which there were no further funds available. He agreed to furnish a roller if I would agree to find a job on which to experiment with it. The first roller 9 in. in diameter and 4 ft. long, made of No. 18 galvanized iron with heads of the same material and weighing 46 lb., was placed on Division 5 of our County Bond Roads. The contractor, Prendergast-Clark Construction Co., agreed to give it a trial. So impressed was Mr. Prendergast by the work done by this roller that he wouldn't be without one. This roller has been in use some two months and has surpassed our expectations leading to our determination to further experiment with sizes and weights till an ideal roller is produced.

Finishing Rollers for Concrete Roads, Vermilion County, Illinois.

Four additional rollers made of No. 20 galvanized iron have since been placed. The Granite City Lime

& Cement Co. has placed one on each of its Divisions 2 and 7. This roller is 12 in. in diameter, 4 ft. long, with wood heads, and weighs 56 lb. P. M. Johnston & Co. has one on Division No. 8. This is 10 in. in diameter, 5 ft. long, weighing 54 lb. John F. McMahon has a roller on Division 6. This is 12 in. in diameter, 5 ft. long and weighs 66 lb. It is difficult to determine which of these rollers is the best. All show splendid results, but the roller 12 in. in diameter and 4 ft. long seems to be most convenient. The larger sizes are clumsy and unwieldy. One man can readily handle the smaller size.

The immediate effect of the use of these rollers is a marked lessening of the water content, a forcing down of the coarse aggregate (particularly as applied to crushed stone) leaving a smooth dense surface which is easy to finish. These rollers are popular with engineers, contractors and workmen. All seem to take a particular interest in seeing them work successfully. The rollers have prevented almost entirely hair checking and wind cracks in hot and windy weather. This latter effect alone would justify their use as all familiar with this class of work can attest. The most valuable effect, however, is that it lessens the cost of finishing and makes a better finish than either the hand float or belt.

Use of Roller.

The method used here is as follows: Immediately after the template is see-sawed across the forms the roller fitted with a 10-ft. handle (it may be longer for wider roads) is pushed slowly across the concrete and then is pulled back again over the same area. The roller is lifted forward the length of itself, and the rolling continued until the template is reached. A stream of water free of cement and aggregate flows in a wide stream ahead of it and over the side forms as the roller moves in each direction. After the roller is used the first time a long handle float is drawn across the pavement, smoothing the surface. Water rapidly collects on this surface. The use of the roller a second time disposes of this water by pushing it over the side as the roller moves back and forth. If a great excess of water happens to be used, rolling must be continued till the excess disappears. Concrete roads caught in the rain may be refinished readily by using the roller. After the second rolling the concrete is ready for final finish with long handle float.

An accurate record of the stations on the various divisions where the rollers are in use is on file for future observation of the roads under traffic.

Types of Lamps Used in Park Lighting

Some interesting figures on the types of lamps used for lighting parks are contained in a recently issued bulletin of the U. S. Census Bureau. The following statement shows the per cent relation of the number of lamps of each type:

	Per cent of total number.		
Type of lamp	Park lighting, 1916.	Street lighting, 1909.	Street lighting, 1907.
Electric arc	8.5	34.5	34.2
Incandescent electric	80.1	16.3	10.6
Gas	6.2	41.5	45.1
All other	5.3	7.7	10.1

The percentages for park lighting are based on returns from 213 cities of over 30,000 inhabitants each. The comparative figures on street lighting are based on statistics for 1907 and 1909 obtained from 158 cities, they having over 30,000 population each.

Non-Assessable Property and Street Improvements

A well deserved criticism of the practice of not assessing churches, schools, etc., for street improvements was given by Mr. M. B. Cowden, City Engineer of Harrisburg, Pa., in a paper presented at the recent convention of officials of Pennsylvania Cities of the Third Class. An abstract of the paper follows:

We have paid out for churches $42,000, for schools $29,000, and for other organizations chartered "not for profit" $29,000, making a total of $100,000. To my mind all except the smallest percentage of this is wrongfully taken from our treasury. Tell me any good reason why churches with rich congregations should be helped by the poor and rich in no way connected with them. Other congregations whose members are not so well supplied with this world's goods are necessarily dependent upon the charity of those able to give, and this should be cheerfully given and not taken from those unable or unwilling to pay. I could cite you many cases of churches in this city, fully able to meet all their obligations, for whom the taxpayers paid the assessments for street paving and curbing.

An example of how this non-assessable business works is the following: The taxpayers of Harrisburg paid out for the paving and curbing around the highways surrounding the Harrisburg Cemetery Association over $9,000. It is true that this corporation is one "not for profit"; that is, no dividends are, or can be, declared by it. Notwithstanding this, it has plenty of money derived from the sale of lots and from other sources to maintain its property in the very best manner. In fact, considerable money must have been, and is being expended very efficiently to procure the pleasing landscape effect even in this City of the Dead. Why should persons, in no way connected with the lot owners of this cemetery, be compelled to pay for their paving assessments? It is true that in small villages where the interests of the property owners are almost identical no hardship is found in paying such obligations, but that is far from being the truth in cities of the third class.

With the organizations for charity solely there might be some good argument advanced for the city's help, but as these depend upon the money of those able and willing to give, for their support, it would seem that the additional comparatively small amount needed for paving might be raised in the same way. This would obviate the trouble experienced of deciding what is or what is not non-assessable, as all well know that there are many cases which are extremely close and at times have to be decided by the courts.

Surely there can be absolutely no good reasons given why the city proper should pay any obligations whatever of the shool boards. They have their own organization, raise their own money, fix their own tax rate and pay all other obligations; then why not pay their assessments for city improvements.

According to the report of the assessor for Los Angeles County, California, there were in the county in 1900 6 automobiles and 47,000 horses. The report for 1910 showed 11,000 motor vehicles and 31,000 horses. Recent figures from the assessor's office show 80,000 motor vehicles and 20,000 horses in the county.

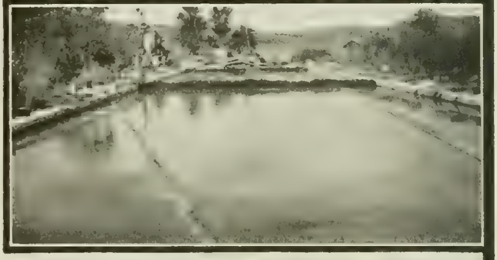
The 4 in. Concrete Roads of California State Highway Commission

Taking out the Subgrade with Wooden Drag Operating on Headers

Rolling with 12 Ton Roller

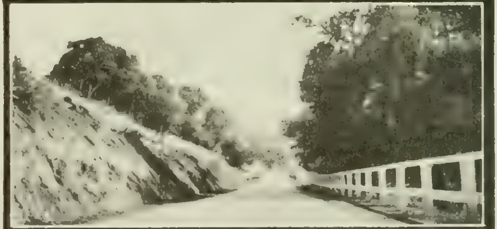
Subgrade Ready for Rolling

Mixing, Laying and Tamping 4" Base



Dike Method of Curing Concrete

Completed Pavement not yet Opened to Traffic



Completed Road Open to Traffic

When the State Highway Commission of California began actual construction in July, 1912, on the system of state highways, certain types of the pavement adopted for the work, were somewhat radical departures from lines of standard practice. Dire predictions of failure were freely made for the pavement with a 5 in. concrete base and a 1 in. to 1½ in. standard asphalt wearing surface. But the type that came in for the most criticism was the one consisting of a 1 to 7½ concrete base, 4 in. in thickness, with a thin bituminous top or wearing surface.

The pavement with the 1-in. asphalt wearing surface has proved a success. The 1-in. surface did not "break up like thin ice as soon as subjected to travel." The difficulty of binding the surface to the concrete without the use of a binder course was solved by the simple expedient of using a paint coat. This paint coat consisted of approximately 1 part, by volume, of asphalt cement heated to a temperature of between 250 and 300° F., to 2 parts, by volume, of engine distillate, the whole in a liquid form being poured over the concrete base and worked out with hand brooms. So good a bond was obtained the asphalt wearing surface in most cases could not be separated from the concrete base without first rupturing the concrete.

As to the 4-in. pavement, it is sufficient to say that 1000 miles of this type have been laid by the State Highway Commission and that it has been or is being adopted throughout the state by many counties and also is being laid on many city streets. The failures of this type as laid by the state, according to an address by Mr. Walter C. Howe, Division Engineer of the State Highway Commission, delivered before the San Francisco Association of Members of the American Society of Civil Engineers, have not been any greater, if indeed as great, as the number of failures of pavements laid by municipal authorities under the more expensive and modern specifications in many of the large and small cities of the Pacific Coast.

Of the few actual failures of State Highways to date the principal causes are enumerated by Mr. Home as follows:

1—The use of unscreened gravel in some of the earlier contracts.

2—Improper curing of concrete base, since corrected by adopting the check method.

3—Opening of concrete pavement to traffic too soon.

4—Improper sub-grade insufficiently compacted.

5—Shallow sub-grade causing installation of pavement less than 4 in. thick.

Cost Keeping Records for Road Construction and Maintenance in the State of Washington

A comprehensive system for recording cost data on the construction and maintenance of roads in the state of Washington has been prepared by a joint committee consisting of George F. Cotterill, State Highway Engineer of Washington, Dean A. H. Fuller, Dr. H. H. Berison and Major Wm. C. Allison of Washington University, T. Ives Dodge, County Commissioner of Thurston County, W. C. Bickford, County Engineer of Snohomish County and David H. White, County Engineer of Pierce County. In these reports the joint committee divides all roads into four classes: Class A being improved roads with hard surface pavement; Class B, improved roads with gravel, broken stone, macadam or plank-surface; Class C, improved earth roads; Class D, unimproved traveled roads. Two forms of reports are required for each of these types of roads: One for maintenance to be made on a yellow colored blank; and the other for construction summary on a white blank. The forms prepared by the committee are reproduced below.

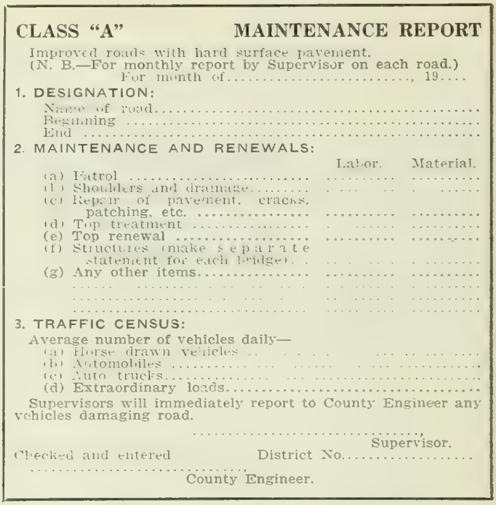
The importance of keeping such cost records was outlined in the report of the committee presented last month by Mr. David H. White at the convention of the county engineers of Washington. The matter in this article is taken from Mr. White's paper:

Complete and accurate cost data and records in the construction of roads are very essential, as by such records, after being kept for a number of years, we will be enabled to determine, beyond the shadow of a doubt, as to the best type of pavement, the most economical and satisfactory, and can also determine the best method of construction for hard surface pavements, or for gravel, earth, broken stone, macadam, or other types of roads.

These cost keeping records should be a part of our office records and balance with the gross expenditures. Cost records will be a check which will show the comparative accomplishment of the different counties, or different foremen or contractors in the same county, and result in greater efficiency and lower unit costs.

We do not know how long roads will last under the different conditions of traffic, nor what is the best paving material in all cases. If accurate costs are kept on each particular type of paving, the methods used in its construction, the amount and character of traffic going over it, and the cost of maintenance, we will be enabled to determine after a number of years to a great nicety what is the best type of pavement, and will have data giving invaluable results.

The County Engineer should analyze expenditures in road construction, with a view to improving foremanship, the class of laborers, plant equipment and material, and have the means of accurately estimating the probable cost of any particular work. A friendly rivalry would then take place between managers, superintendents and workmen, and each man would be impelled to do his best, realizing that thereby his merit would be known and better results received. More co-operation between contractors and engineers in the matter of cost data is desirable. Many contractors are averse to giving out their cost data to the County Engineer. In order to get these data in



CLASS "A" **MAINTENANCE REPORT**

Improved roads with hard surface pavement.
(N. B.—For monthly report by Supervisor on each road.)
For month of........................., 19....

1. DESIGNATION:
Name of road.......................................
Beginning ....
End ....

2. MAINTENANCE AND RENEWALS:

	Labor.	Material.
(a) Patrol	....	....
(b) Shoulders and drainage........	....	....
(c) Repair of pavement, cracks, patching, etc.	....	....
(d) Top treatment	....	....
(e) Top renewal	....	....
(f) Structures (make separate statement for each bridge). .	....	....
(g) Any other items................	....	....
....	....	....
....	....	....
....	....	....

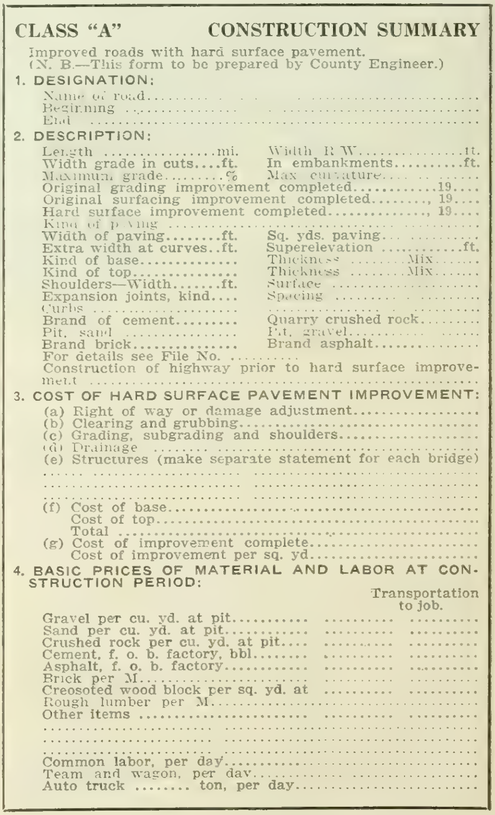
3. TRAFFIC CENSUS:
Average number of vehicles daily—
(a) Horse drawn vehicles ....
(b) Automobiles ....
(c) Auto trucks....................................
(d) Extraordinary loads............................

Supervisors will immediately report to County Engineer any vehicles damaging road.

................................,
Supervisor.

Checked and entered District No..................
................................,
County Engineer.

Fig. 1—Form for Maintenance Report for Improved Roads With Hard Surface Pavement.



CLASS "A" **CONSTRUCTION SUMMARY**

Improved roads with hard surface pavement.
(N. B.—This form to be prepared by County Engineer.)

1. DESIGNATION:
Name of road.......................................
Beginning ....
End ....

2. DESCRIPTION:

Length ....mi.	Width R W................ft.
Width grade in cuts....ft.	In embankments..........ft.
Maximum grade.........%	Max curvature..............

Original grading improvement completed...........19....
Original surfacing improvement completed........, 19....
Hard surface improvement completed.............., 19....
Kind of paving ....

Width of paving........ft.	Sq. yds. paving............
Extra width at curves..ft.	Superelevation ....ft.
Kind of base..............	Thickness ....Mix......
Kind of top...............	Thickness ....Mix......
Shoulders—Width.......ft.	Surface ....
Expansion joints, kind....	Spacing ....
Curbs	....
Brand of cement.........	Quarry crushed rock........
Pit, sand	Pit, gravel................
Brand brick..............	Brand asphalt..............

For details see File No. ....
Construction of highway prior to hard surface improvement ....

3. COST OF HARD SURFACE PAVEMENT IMPROVEMENT:
(a) Right of way or damage adjustment..................
(b) Clearing and grubbing...............................
(c) Grading, subgrading and shoulders...................
(d) Drainage ....
(e) Structures (make separate statement for each bridge)
....
....
....
(f) Cost of base..
Cost of top...
Total ....
(g) Cost of improvement complete........................
Cost of improvement per sq. yd......................

4. BASIC PRICES OF MATERIAL AND LABOR AT CONSTRUCTION PERIOD:

		Transportation to job.
Gravel per cu. yd. at pit..........	....	....
Sand per cu. yd. at pit...........	....	....
Crushed rock per cu. yd. at pit....	....	....
Cement, f. o. b. factory, bbl.......	....	....
Asphalt, f. o. b. factory...........	....	....
Brick per M.......................	....	....
Creosoted wood block per sq. yd. at	....	....
Rough lumber per M................	....	....
Other items	....	....
....	....	....
....	....	....
....	....	....

Common labor, per day...................................
Team and wagon, per day.................................
Auto truck .... ton, per day........................

Fig. 2—Form for Construction Summary for Improved Roads With Hard Surface Pavement.

CLASS "B" MAINTENANCE RECORD

Improved roads with gravel, broken stone, macadam or plank surface.
(N. B. For monthly report by Supervisor of each road.)
Report for ...., 19....

1. DESIGNATION:
Name of road ....
Beginning ....
End ....

2. MAINTENANCE AND RENEWALS:

	Labor	Material.
(a) Patrol	....	....
(b) Dragging or rolling..........	....	....
(c) Cleaning ditches, etc..........	....	....
(d) Repair of structures (make separate statement for each bridge)	....	....
(e) Renewal of surface..........	....	....
(f) Other items	....	....
....	....	....
....	....	....

3. IMPROVEMENTS (to be entered by County Engineer).
(a) Right of way or damages..........................

	Labor.	Material.
(b) Clearing and grubbing..........	....	....
(c) Grading	....	....
(d) Drainage	....	....
(e) Structures (give separate statement for each bridge)	....	....
(f) Surfacing	....	....
(g) Other items	....	....
....	....	....
....	....	....

4. ENGINEERING:
(a) Location ....
(b) Office ....
(c) Inspection ....

5. TRAFFIC CENSUS:
Average number of vehicles daily—
(a) Horse drawn vehicles..........................
(b) Automobiles ....
(c) Auto trucks ....
(d) Extraordinary loads ....

Supervisors will immediately report to County Engineer any vehicles damaging roads

....
Supervisor.
Checked and entered District No... ....
..........................,
County Engineer.

Fig. 3—Form for Maintenance Record for Improved Roads With Gravel, Broken Stone, Macadam or Plank Surface.

CLASS "B" CONSTRUCTION SUMMARY

Improved roads with gravel, broken stone, macadam or plank surface.
(N. B.—This form to be prepared by County Engineer.)

1. DESIGNATION:
Name of road..........................
Beginning ....
End ....

2. DESCRIPTION:
Length ....mi. Width, R/W.............ft.
Width grade in cuts......ft. In embankments.........ft.
Maximum grade..........% Max curvature ....
Original improvement completed....................19....
Surfacing completed ....19....
Character of surfacing..........................
Width of surfacing.......in. Depth of surfacing.......ft.
Quarry for crushed rock..........................
Pit for sand..........................
Pit for gravel..........................

3. COST:
(a) Right of way or damages..........................
(b) Clearing and grubbing..........................
(c) Grading ....
(d) Drainage ....
(e) Structures (make separate statement for each bridge)
....
(f) Surfacing ....
(g)) Other items ....
....
....
....
(h) Total cost at beginning of maintenance record........
.........., 19....

4. PRICES AT CONSTRUCTION PERIOD:
Common labor per day........ Team and wagon........

		Transportation to job.
Gravel, per cu. yd. at pit..........	....	....
Crushed rock, cu. yd. at quarry....	....	....
Lumber per M. at mill..........	....	....

5. ENGINEERING:
(a) Location ....
(b) Office ....
(c) Inspection ....
General condition of road..........................19....
At beginning of maintenance record..........................

Fig. 4—Form for Construction Summary for Improved Roads With Gravel, Broken Stone, Macadam or Plank Surface.

Pierce County, we require the following clauses to be inserted in every contract:

A certified copy of the contractor's pay roll for each month must be filed in the County Engineer's office not later than the 5th day of the following month.

The bidder to whom this contract is awarded will, upon its completion, be required to file with the Board of County Commissioners a sworn statement, accompanied by vouchers showing the cost of all labor and matter used, and the net profit on the job.

The Joint Committee on Cost Data for Construction and Maintenance of Roads has spent a great deal of time in preparing an act for submission to the legislature and in preparing forms for records of construction and cost data for road construction and maintenance. The bill as prepared by this committee was modified by a sub-committee on roads and bridges in the legislature to read as follows:

CLASS "C" MAINTENANCE REPORT

Improved earth roads.
(N. B.—For monthly report by Supervisor on each road.)
Report for..........................19....

1. DESIGNATION:
Name of road..........................
Beginning ....
End ....

2. MAINTENANCE AND RENEWALS:

	Labor.	Material
(a) Patrol	....	....
(b) Dragging or rolling..........	....	....
(c) Cleaning ditches, etc..........	....	....
(d) Repair structures (make separate statement for each bridge)	....	....
....	....	....
(e) Surfacing	....	....
(f) Other items	....	....
....	....	....
....	....	....

3. IMPROVEMENTS (to be entered by County Engineer):
(a) Right of way or damages..........................

	Labor.	Material.
(b) Clearing and grubbing..........	....	....
(c) Grading	....	....
(d) Drainage	....	....
(e) Structures (give separate statement to each bridge)....	....	....
....	....	....
....	....	....
(f) Surfacing	....	....
(g) Other items	....	....
....	....	....
....	....	....

4. ENGINEERING:
(a) Location ....
(b) Office ....
(c) Inspection ....

5. TRAFFIC CENSUS:
Average number of vehicles daily—
(a) Horse drawn vehicles..........................
(b) Automobiles ....
(c) Auto trucks ....
(d) Extraordinary loads ....

Supervisors will immediately report to County Engineer any vehicles damaging road.

....
Supervisor.
Checked and entered District No................
....
County Engineer.

Fig. 5—Form For Maintenance Report for Improved Earth Roads.

Relating to a system of cost records of maintenance and repairs of public roads, imposing certain duties upon the state highway commissioner, board of county commissioners, county engineers and other officers in reference thereto.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON:

Sec. 1. For the purpose of providing actual and comparative information of the costs of maintenance and repairs of the various types of public roads, it is hereby required that the state highway commissioner, boards of county commissioners, county engineers, and other public officers charged with such work, shall keep a system of segregated cost reports to be made at least once each month by the supervisor or foreman in direct charge of any such road maintenance or repairs. Such reports as to state highways under direct maintenance control of the state highway department shall be made to the state highway commissioner and checked, tabulated and recorded. As to other roads, such reports shall be made in each county to the board of county commissioners and transmitted to the county engineer for checking, tabulation and record thereof. The county en-

engineer shall upon call of the state highway commissioner at any time, and at least annually, compile and furnish consolidated reports from the road maintenance records in his charge. All such records, whether in the office of the state highway commissioner, or of any county engineer, shall be available for reference of public officials, good roads associations, the press and public generally. Each annual or biennial report of the state highway commissioner, or of any county engineer, shall include a tabulated summary of the actual and comparative costs of road maintenance and repairs of the various types of roads under their respective jurisdictions, compiled from the reports received from the supervisor and foreman as hereinbefore required. The provisions of this act shall not apply to roads or streets within the limits of incorporated cities, except as to such main routes therein which are part of state highways or county roads and maintained as such under state or county supervision.

CLASS "C" CONSTRUCTION SUMMARY

Improved earth roads.
(N. B.—This form to be prepared by County Engineer.)

1. DESIGNATION:
Name of road..
Beginning..
End..

2. DESCRIPTION:
Length....................mi. Width R/W..............ft.
Width grade in cuts......ft. In embankment.........ft.
Maximum grade..........% Max curvature............
Original improvement completed.......................19....
Additions completed..........................19....

3. COST:
(a) Right of way or damages..........................
(b) Clearing and grubbing..........................
(c) Grading..........................
(d) Drainage..........................
(e) Structures (make separate statement for each bridge)
....
....
(f) Surfacing..........................
(g) Other items..........................
....
....
(h) Total cost of improvement at beginning of maintenance record......................., 19....

4. PRICES AT CONSTRUCTION PERIOD:
Common labor per day........ Team and wagon........
Rough lumber at mill per M..........................

5. ENGINEERING:
(a) Location..........................
(b) Office..........................
(c) Inspection..........................
General condition at beginning of maintenance record:
........................, 19....
....

Fig. 6—Form for Construction Summary for Improved Earth Roads.

CLASS "D" MAINTENANCE RECORD

Unimproved traveled roads.
(N. B.—For monthly report of Supervisor on each road.)
Report for........ ...., 19....

1. DESIGNATION:
Name of road..
Beginning..
End..

2. MAINTENANCE AND RENEWALS:

	Labor.	Material.
(a) Patrol..................	....	....
(b) Dragging..................	....	....
(c) Cleaning ditches, etc..........	....	....
(d) Repair structures (make separate statement for each bridge)..........	....	....
....	....	....
(e) Surfacing..................	....	....
(f) Other items..................	....	....
....	....	....
....	....	....

3. IMPROVEMENTS (to be entered by County Engineer):
(a) Right of way or damages..........................

	Labor.	Material.
(b) Clearing and grubbing..........	....	....
(c) Grading..................	....	....
(d) Drainage..................	....	....
(e) Structures (make separate statement for each bridge)...	....	....
....	....	....
....	....	....

4. ENGINEERING:
(a) Location..........................
(b) Office..........................
(c) Inspection..........................

5. TRAFFIC CENSUS:
Average daily number of vehicles—
(a) Horse drawn vehicles..........................
(b) Automobiles..........................
(c) Auto trucks..........................
(d) Extraordinary loads..........................
Supervisors will immediately report to County Engineer any vehicle damaging road.

....
Supervisor.
Checked and entered District No..................
....
County Engineer.

Fig. 7—Form for Maintenance Record for Unimproved Traveled Roads.

CLASS "D" CONSTRUCTION SUMMARY

Unimproved traveled roads.
(N. B.—This form to be prepared by County Engineer.)
.................................19....

1. DESIGNATION:
Name of road..
Beginning..
End..

2. DESCRIPTION:
Length.......................mi. Width R/W..........ft.
....

3. COST:
(a) Total cost of road at beginning record................
(b) Right of way cost of damages..........................
(c) Cost structure (make separate statement for each bridge)..........................

4. ENGINEERING:
(a) Location..........................
(b) Office..........................

5. ENGINEERING:
(a) Location..........................
(b) Office..........................
(c) Inspection..........................
General condition of road..........................19....
At beginning of maintenance record......................

Fig. 8—Form for Construction Summary for Unimproved Traveled Roads.

The legislative authority of any city or town may provide for similar cost reports of street maintenance and repairs, applying within its jurisdiction.

Sec. 2. The state bureau of inspection and supervision of public offices is hereby authorized and directed to prepare the necessary forms and reports, in accordance with which the costs of maintenance and repairs of the various types of public roads under state and county jurisdiction shall be secured, reported, checked and made a matter of public record. Such records shall include a summarized construction statement of cost as to each road at the beginning of its maintenance record, with provision for supplemental reports of any improvements or additions thereafter made as distinguished from ordinary maintenance and repairs.

Uniform Plans for Earth Road Grading in Missouri

The State Highway Department of Missouri has sent out typical plans and specifications to encourage a uniform system of grading on earth roads in the state. The minimum radius of curvature permitted for rounding right-angle turns on state roads is also given, and approved methods of hard-surfacing are suggested. The department recommends that wherever possible earth roads should be graded 30 ft. between ditches, with a 24 ft. trafficway, and a crown not to exceed ¾ in. to the foot. A narrower road, which will be approved in rugged sections, is 24 ft. between ditches, with a 20 ft. trafficway. A slope of 3 in. to the foot into the ditches is recommended.

In the month of May, freight transportation service rendered by about 75 per cent of Class I railroads of this country was 16.1 per cent in excess of the service rendered in 1916. In that year, which was one of unusual activity, the freight service rendered by the carriers was 24 per cent greater than in 1915. So the carriers have achieved the feat of adding to their freight service, in the short period of two years, an amount equal to the freight traffic of Great Britain, France, Russia, Germany and Austria combined.

Sheet Asphalt for Country Roads

By E. A. TREGO,

Barber Asphalt Paving Co., Philadelphia, Pa.

A step of the highest significance has been taken recently with respect to country roads subjected to very heavy traffic. Convinced that economy warrants the building of a high class pavement to meet increased volume and weight of traffic—particularly the latter—highway engineers in several States are turning to sheet asphalt on a concrete base.

While this has been described as a far-sighted and advanced movement from an economical point of view, it is neither an innovation nor experiment except as it applies to country roads, for trustworthy precendent as to durable and economical results is to be found in all large cities where pavements of this type have been thoroughly tested for 35 years or more. Strictly speaking they are not an entirely new proposition even as to country roads, for here and there engineers resorted to the type some years ago. For example, nearly 8 miles of Road No. 250, in New York State, known as the Utica-Oneida Castle road, was paved with Trinidad Lake sheet asphalt on a concrete base in 1906. A report under date of Aug. 15, 1916, states that the road at that time was in perfect condition after 10 years' service and that during this period not a cent had been expended for repairs. This road is subjected to extremely heavy traffic, being a continuation of Genesee St., Utica, the main artery of travel out of the city of Utica.

17-Year-Old Asphalt Pavement on Park Avenue, Norfolk, Va.

In Connecticut, State Highway Commissioner Charles J. Bennett is building roads with the sheet asphalt on a 6-in. portland concrete base, the type that carries nearly 20,000 vehicles per 10-hour day at 5th Ave. and 42d St., New York. Milwaukee County, Wisconsin, has examples of the type built in 1914 and 1915. Burlington County, New Jersey, has let contracts for several miles, and bids were received at the County Engineer's office in Wilmington, Del., on Aug. 14 for sheet asphalt and concrete construction on a section of the Lincoln Highway.

The adoption of sheet asphalt and concrete for country roads subjected to the conditions described, seems to emphasize the oft-repeated statement that one of the greatest mistakes made in highway improvement throughout the United States has been the construction of cheap pavements for heavy traffic country roads. Where roads built under bond issues have failed and conditions necessitated rebuilding within a quarter of the time allotted for the maturity of the bonds, communities so situated have had convincing evidence of the truth of the saying that a cheap pavement may be the costliest in the end.

While practical illustrations of the ultimate economy of enduring pavements are not as common as examples of false economy growing out of reluctance to pay for sound construction in the beginning, their number is more than sufficient to prove the statement. A case in point, selected because it represents average rather than extreme city traffic conditions, relates to a street in Norfolk, Va. In the fall of 1900 the city laid on Park Ave. 7,320 sq. yd. of Trinidad sheet asphalt on a concrete base. Inquiry as to maintenance was made on May 1, 1917, after the pavement had been in constant use for nearly 17 years. The report was that only 42 sq. yd. had required maintenance. Had this maintenance involved complete renewal of the affected area at the original cost per square yard, it would have meant a total expenditure of perhaps $100 for a period of 17 years. A photograph of the street was taken on May 1 last, and is reproduced herewith. It is a matter of official record that many streets of the same type subjected to even greater traffic than the Norfolk street have shown like endurance for periods of 20 and 25 years.

Thus it cannot be said that the engineers now resorting to sheet asphalt surfaces and concrete foundations for country roads are engaged in a doubtful undertaking. On the contrary, it seems to be a logical development, following the lines of progress that have characterized the paving of city streets. When country roads carry quantities and weights of traffic closely approximating urban conditions, it must be expected that what up to now have been considered "city pavements" will extend into country districts. The service demanded of a road must be the factor that determines the character of construction rather than the mere question as to whether the road traverses a rural or urban locality.

That the foregoing is true is shown by the insistence on the part of eminent highway authorities that the mere cheapness of a pavement bears little relation to true economy and that nothing is more unreliable and misleading than the assumption that if a country road carries 50 per cent of the traffic of a city street it should be 50 per cent cheaper than the latter. This theory takes no account of a very common menace to highways, i. e., greatly increased weight of traffic, such as is imposed by the heavy motor truck. In other words, success comprehends many factors other than volume of traffic. There have been many cases where a very small percentage of the total traffic of a road has destroyed it.

Asphalt Pavement on Whitefish Bay Road, Milwaukee County, Wisconsin.

While initial cost has long been a deciding factor in the selection of roads, communities in which motor traffic is the predominant type have learned that a thoroughly good road will, in a sense, pay for itself, for a road of this type at once greatly lessens operating expenses. In brief, the road user may continue the wasteful expenditures for gasoline, oil and tires always occasioned by bad roads, to say nothing of attending discomforts, or he may invest the money in a thoroughly good road, which a very small saving in operating expenses will pay for in a very short time. Proof of this may be found wherever good roads have been substituted for bad roads.

That road economy as it pertains to the road itself was not as readily understood as the economy obtained by substituting automobiles for horses, was perfectly natural. Even an inferior type of road permitted the motorist to get somewhere at greater speed than a horse could convey him, and the senation of being carried up hill and down dale by an untiring mechanical device is still sufficiently novel and pleasing to cause many to ignore the fact that roads, in the matter of utility and economy, should correspond to the perfection of the automobile and motor truck. The situation is not unlike that affecting railroad equipment and road bed. With every advance in the carrying capacity of cars and the speed and weight of locomotives, there became necessary a corresponding improvement in rails, ties, ballast and bridges. It would rightly be thought absurd to attempt to move present day locomotives and freight cars over the roadbeds that were adequate 30 years ago. It is just as absurd to expect the highways of forme days to carry the traffic weights of today, and yet that is what is done in too many instances. Therefore recourse in roadbuilding to the concrete base and the dense, wear-resisting surface of heavy traffic city pavements shows a realization of present-day requirements that is highly encouraging.

On the basis of experience with thousands of miles of city streets, it may be confidently said that sheet-asphalt-concrete-base roads will not break down under heavy traffic. The same experience has demonstrated high surface resistance to abrasion as distinguished from wearing surfaces that ravel or become dispersed. An unyielding concrete base will bridge depressions in the sub-base and should last indefinitely. How frequently repairs would be required is indicated by the Norfolk street as well as millions of square yards of this type of pavement on other heavy traffic streets in this country and abroad.

Gravel Roads Damaged by Cleats on Tractors

The Service Bulletin of the Iowa Highway Commission calls attention to the damage caused to gravel roads by the spikes or cleats of tractors. The spikes or cleats cut into or through the gravel crust and tear it full of holes. The lossened gravel material blows or is carried off, and the holes in the surface fill up with dirt. In rainy seasons they fill with water which stands until it evaporates or penetrates the surrounding gravel, softening it and destroying still further the surface crust. Two or three trips of a heavily cleated or spiked tractor, will almost ruin any sort of gravel road surface. The racking of the tractor due to running over either gravel or paved surfaces with spikes or cleats, should be argument enough to induce tractor men to keep off such surfaces or to remove cleats and spikes when on such highways.

Co-Operative Buying of Road and Bridge Material by Iowa Counties

Co-operative buying of road and bridge materials under standard specifications is contemplated by the Supervisors of the 99 counties of Iowa. The plan was suggested by Mr. T. H. MacDonald, Chief Engineer of the State Highway Commission in a paper presented Aug. 9 at the annual convention of the State Association of County Supervisors. The association endorsed the plan and provided for an executive committee to put it into effect. The committee, according to the instructions, is to proceed at once to ascertain from the several counties their requirements for construction materials for the season of 1918. It will group these requirements and secure bids for furnishing the material. The proposals will be submitted to the county boards who will award the contracts.

The plan as outlined by Mr. MacDonald in his address before the association follows:

In order to continue the road and bridge improvement program in this State, the first essential is to secure the supply of the materials of construction that are to be needed. The resources of this nation are tremendous. They are ample to supply all demands, but there are certain essentials in making available this supply that must be observed. The first is the uncertainty of the qualities required. The second is the time necessary to produce, the third is the question of transportation, and the fourth that of financial responsibility. At this time when large contracts are to be placed, the wants of the small user are likely to be overlooked, and wants of the large user supplied. Also, more time is needed to secure materials. The whole situation is such that our present methods of supplying the needs of the counties of the state are inadequate and fail to give service.

Therefore, I wish to place before this association, the recommendation that an executive committee of this association be formed, whose function will be to plan a co-operative system of buying and supplying materials to the counties, which will give the State the materials we must have during the time that the war continues and as long afterwards as may be found desirable. The nation has formed a National Defense Council, the State has established a State Defense Council, and this association can find in these facts a precedent for acting upon this recommendation.

I would not attempt to present a plan for the organization of this work in detail, but at the outset as a fundamental principle which should be thoroughly understood before any discussion is had of the matter, I would say that this recommendation does not contemplate that the actual placing of the orders or the letting of contracts shall be vested in this committee. The function of this committee would be primarily to gather, beginning at once, the estimated requirements for 1918, of materials such as lumber, reinforcing steel, cement, sand, gravel, and like materials, and then to locate supplies of these materials, obtain prices or bids and submit these bids to the counties. If we consider the needs of the State as a whole, it is apparent that there has been a great loss of efficiency in buying, and that the requirements of the State as a whole have never been grouped so as to attract the companies or corporations having control of large supplies of these materials. It is urged that this is a serious task and an immense one, but that it is a work well worth doing and one that will result in the saving of hundreds of thousands of dollars, if provision is made by this association for working out and making effective a plan along the line submitted in this recommedation.

Take, for instance, the purchasing of bridge lumber. We have reliable information that there is a large supply of lumber at the mills and that the only difficulty in obtaining the delivery of this material promptly is the shortage of cars. In the first place, it is an assured fact that a large number of cars must be brought into Iowa this fall and winter to be filled with the foodstuffs which Iowa will have to ship, and there is no reason why these cars should be shipped into the State empty, if there are materials which Iowa needs from the outside. If an executive committee from this association will gather at once estimates from the various counties as to the amount of bridge lumber they will need next year, and submit these estimates to bidders, allowing six months' delivery, the amount of the lumber required will be such as to attract the attention of large producers both in the south and on the west coast, and with a long time delivery, most favorable prices should be secured. The requirements of the various counties would be listed, and as soon as the bids were received, these prices would be submitted to the individual county boards, for their acceptance or rejection as they may see fit. When the United States government desired to purchase large quantities of lumber for building the army cantonments, it received very favorable bids from both the western and southern producers. In fact, the rivalry was so keen as to which section should deliver the lumber at the earliest date that wagers were made between the western and southern producers' associations, and lumber from the southern States rushed through to the camp at Des Moines in special trains. We do not need this material delivered in special trains, but we do not want to have contracts for material which is diverted en route and sold at higher prices while we wait.

The same general situation holds true of reinforcing steel. Both lumber and reinforcing steel are materials that can be stored without deterioration.

The principles upon which these recommendations are based are first, that if the State of Iowa can obtain bids on large quantities of materials, that more favorable prices will be received, and if these bids can be taken very soon for next year's work, there will be no question about obtaining deliveries of the material at the time it is needed. It must be emphasized that the action of an executive committee would not be final, and that all contracts would be made by the individual county boards, if the prices secured were considered better than they could secure from any other source, and no board would be bound or committed to purchase unless it so desired, after bids were received.

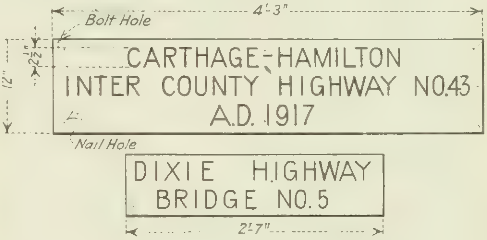
It should be further emphasized that this is a work which can be handled by your association. Such clerical assistance as might be needed by your committee, I believe, would be willingly supplied by the Highway Commission, and I have no doubt that the Attorney General's Department would gladly assist so far as any legal questions are involved.

The producers of materials know that the counties are financially responsible, and I am very strongly of the opinion that a plan of this character could be worked out not only for lumber and reinforcing steel, but for other materials of construction which are needed, as well.

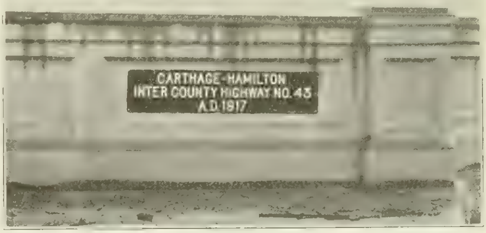
A committee formed by this association, of representative supervisors from each congressional district in the State, has immense possibilities for saving large sums of money to the taxpayers of the State at this time, and would be able to secure a continuance of road and bridge improvement. The field of usefulness which might be occupied by such a committee is only partially indicated in what I h. said.

Highways Designated by Markers on Bridges and Culverts

The road officials of Hamilton County, Ohio, have adopted the practice of placing metal markers on bridges and culverts to designate the highway and to convey such other information as may be desired. The signs are fixed on both inner sides of parapets of bridges and of culvert headwalls where they extend far enough above the surface of the road. The accompanying illustration shows the sign on the Woodlawn Bridge over the west fork of Mill Creek, which was erected jointly by the State and the county. This road is a section of the Dixie Highway, and as a consequence two other signs stating this fact and giving the bridge number also have been placed on the bridge.



Sketch Showing Dimensions of Marker.



Marker on Woodlawn Bridge, Hamilton County, Ohio.

The signs are made of number 12 gage 99.84 pure iron. The letters are milled to a depth of 1/16 in. and after being galvanized are covered with aluminum paint, the balance of the plate being covered by two coats of paint (any color) baked. They are fastened to the forms by nails and anchored into the concrete by bolts. Letters can be made any size. The cost is about 7½ ct. per letter. The sign shown cost $3. Wm. H. Boeh is County Surveyor of Hamilton County.

Weight and Amount of Traffic on Iowa Country Roads

Interesting statistics on the amount and weight of traffic on country roads in Iowa have been obtained from a traffic census conducted by the State Highway Commission and the Engineering Experiment Station at Ames in connection with proposed Federal aid projects. Results of this census were outlined by Mr. Thos. H. MacDonald, State Highway Engineer, in an address delivered last month before the State Association of County Supervisors.

In order to determine more accurately the actual amount of traffic, a set of scales was used to weigh the traffic going over the various roads, and the result confirms the increased use of the roads that has been apparent from observation. Such a weighing station was installed 2 miles south of Ames, a town of 5,000 people, and the traffic weighed for a period of 10 days. During this time a total of 1,995 vehicles passed over the road, an average of about 200 per day. These vehicles, including their own weight, carried 4,919,468 lb. of weight, or an average of about 500,000 lb. of weight for every day. During the 10-day period, 5,560 people went over the road, or an average of 556 per day.

In Jefferson County, near Lockbridge, the total number of vehicles over the road for one week was 888. At Van Wert, in Decatur County, 691; at Correctionville, in Woodbury County, 1,257; at Clear Lake in Cerro Gordo County, 7,044; in Delaware County, on the Hawkeye Highway, the total was 2,996. A summary for the eight stations for which the counts have already been taken and which are established on roads typical of the country roads leading into market centers all over the state, shows total of 74,203 passengers and 22,858 vehicles. The total number of days during which the above traffic was counted is 59, which makes a daily average of 1,259 people and 387 vehicles. It will be noted that this is about double the daily average traffic for the weighing station established at Ames, and on the basis of the actual weights taken at that station, the average for the eight roads would show almost 1,000,000 lb. of traffic per day.

The most surprising feature of the count is the number of people that are now using the roads. On the Mason City-Clear Lake road the count for one week showed that over 25,000 people traveled this one road. The combined population of Mason City and Clear Lake is about 22,000. This means that the number of people who had used the road in one week was greater than the number of people in both Mason City and Clear Lake by a margin of approximately 3,000.

From time to time there has been criticism made of the improvement of roads for tourist travel, on the theory that the tourist traffic is detrimental to the roads and that the tourists do not contribute to the cost of improvement and maintenance. In order to obtain information on this point, the tourist count was accurately kept, and out of the entire number of 22,000 vehicles passing over the roads, at the eight stations, only 669 were strictly tourists; that is, only about 3 per cent of the traffic was tourist, and the stations at which these records were taken include some of the best cross-State routes, among them being the Hawkeye Highway, the Jefferson Highway, Blue Grass Road, with one station between the Lincoln Highway and the city of Des Moines. The amount of town-to-town traffic is large and indicated that there must be a readjustment in the method of levying taxes for the improvement of the main county highways, so that city and town property will bear a larger proportion of the cost of this improvement, but the actual count emphasizes the fact that it is the people of each community in the State who are using the roads, and not the people of other States. It is doubtful if the people of other States use the roads of Iowa in anything like the proportion that the people of Iowa use the roads of the States on the east and west coasts.

Influence of Road Surface on Tractive Resistance

Tests to determine the tractive resistance of a loaded farm wagon on various road surfaces have been made recently by J. B. Davidson, Professor of Agricultural Engineering, University of California, for the Good Roads Bureau of the California State Automobile Association. The tests were made in part at the University Farm, near Davis, in Yolo County, California, and upon the State highway in the vicinity and over various county roads and stretches of the State highway in Sacramento County, near Sacramento. The types of roads on which the tests were made were as follows:

Earth road, dust ¾ to 2 in. deep.
Earth road, stiff mud, firm underneath.
Gravel, compact, in good condition.
Gravel, loose, not packed.
Water-bound macadam, good condition.
Oil macadam, new, good condition.
Concrete, unsurfaced, smooth.
Concrete, ⅜-in. top, asphaltic oil and screenings
Concrete, 1½-in. Topeka top.
Topeka top, 1½-in., on plank, approach to causeway

As far as possible all factors influencing the tractive resistance of a loaded wagon, except the road surface itself, were either eliminated or maintained constant throughout the tests. Thus one wagon with the same load was used and was drawn by a team in all the tests, except those on an oil macadam road, where a motor truck was used. The tests were made on June 13 and July 9 and 10. The weather was bright and sunny in each case and the highest temperature for each day was about 105°. The warm weather was the occasion for an increased tractive resistance on the oil roads over that for average temperatures.

The rate of travel was decided in each case and averaged 2.4 miles per hour for the team. On grades tests were made both up and down grade and the results averaged.

The wagon was of the standard farm type with steel axles of equal length, with wheels 38 and 46 in. in diameter and 4-in. tires. The load consisting of rice in sacks, weighed 6,000 lb. gross. The team consisted of two heavy draft horses, weighing about 1,600 lb. each. In the tests on oil macadam the load was drawn by a motor truck.

The dynamometer was of the integrating and recording type known as the Iowa. The force representing the tractive resistance of the loaded wagon acting through the instrument compresses a spring carefully calibrated to indicate the force acting. The average resistance over a uniform distance, measured automatically, is indicated directly by the instrument at the end of the run. A record of the resistance is also made on a strip of paper drawn under a recording pencil; this record so provided is used to check the average results furnished by the instrument. The tests were started after the load was in motion and moving a uniform rate.

The results of the tests are summarized in the tabulation that follows:

Test No.	Kind of road.	Condition of road.	Tractive. Total. Lb.	Resist. Per ton Lb.
[illegible]	Concrete (Unsurfaced)	Good, excellent	83.0	27.6
*11-12	Concrete (Unsurfaced)	Good, excellent	90.0	30.0
26-27-28	Concrete ⅞ in. surface asphaltic oil and screenings	Good, excellent	147.6	49.2
13-14	Concrete ⅜ in. surface asphaltic oil and screenings	Good, excellent	155.0	51.6
9-10	Macadam Water bound	Good, excellent	193.0	64.3
22-23	Topeka on concrete	Good, excellent	205.5	68.5
8	Gravel	Compact, good condition	225.0	75.0
†45-48	Oil macadam	Good, new	234.5	78.2
‡46-47	Oil macadam	Good, new	244.0	81.3
33	Gravel	Packed, in good condition	247.0	82.3
18-19-20	Topeka on plank	Good condition, soft, wagon left marks	265.0	88.3
34	Earth road	Firm, 1½ in. fine loose dust	276.0	92.0
24-25	Topeka on plank	Good condition, but soft	278.0	92.6
1-2-5	Earth road	Dust ¾ to 2 in.	298.0	99.3
3-4	Earth	Mud, stiff, firm underneath	654.0	218.0
6-7	Gravel	Loose, not packed	789.0	263.0

*Graphic record indicates that the load was being accelerated when test was started. †Drawn with motor truck at 2½ miles per hour. ‡Drawn with motor truck at 5 miles per hour.

Cost of Street Cleaning at San Diego, Cal. with Vacuum Cleaners

The city of San Diego, Cal., has operated vacuum street cleaning machines for the past four years. The first machine was purchased in the fall of 1912 and the second in March, 1913, at a cost of $2,200. The apparatus is drawn by three horses; the vacuum arrangement being run by a small gas engine. The outfit is handled by one gas engineer and one teamster. The machines are worked two shifts a day. The costs of street cleaning with the vacuum machines for the first 7 months of 1917, according to information furnished by Mr. F. M. Lockwood, Manager Operating Department of city of San Diego, were as follows:

VACUUM NO. 1.

	Operation.	Maintenance.	Total cost.	Yardage cleaned.	Cost per 1,000 sq. yd
January	$ 317.61	$ 33.16	$ 350.77	2,923,000*	$0.12
February	397.19	41.34	438.53	3,654,417*	.12
March	398.33	86.17	484.50	4,045,069	.11976
April	406.44	44.73	451.17	2,292,853	.196772
May	418.46	137.61	556.07	3,130,837	.17761
June	41.43	493.07	534.50	In shop	......
July	365.78	186.35	552.13†	2,257,354	.244593
Totals	$2,345.24	$1,022.73	$3,367.97	18,306,620	....
Averages	335.03	146.10	481.13	3,051,103	$0.18397

VACUUM NO. 2.

	Operation.	Maintenance.	Total cost.	Yardage cleaned.	Cost per 1,000 sq. yd
January	$ 350.74	$ 20.77	$ 371.51	3,377,364*	$0.11
February	294.16	23.41	317.57	2,887,000*	.11
March	369.19	16.43	385.62	4,174,581	.092373
April	431.03	38.85	469.88	4,256,759	.11038
May	373.75	27.08	400.83	3,442,492	.116436
June	356.62	.85	357.47	2,985,323	.119743
July	263.74	8.29	272.03	2,947,462	.0923
Totals	$2,439.20	$ 135.71	$2,574.91	24,070,981	....
Averages	348.46	19.39	367.85	3,438,712	$0.106974

*Estimated; no figures available for actual yardage. †This total cost includes a complete overhauling and rebuilding of the entire apparatus.

The above costs include teams at actual cost of feed, care and maintenance of harness, labor, fuel, oil and repairs, but do not include depreciation nor interest on the investment.

Instructions of Kentucky Department of Public Roads for Making Road Surveys and Estimates

The State Department of Public Roads of Kentucky has issued a bulletin of instructions for the guidance of engineers in making of road surveys. The purpose of the publication is to indicate the information required by the Department in order to enable it to approve the work for the proposed highway, and also to state the form in which the information must be submitted. Extracts from the bulletin follow:

Grades.—In new locations it is deemed best by the Department that the grades should not exceed 5 per cent unless under very extenuating circumstances, and if over 5 per cent is made such information should be noted on the profile as will enable the Commissioner to know the conditions where the above mentioned grade is exceeded.

In resurfacing work the fact is appreciated that it will be impossible at times to reduce some of the existing grades owing to the improvements which have been made along the road, but such should be noted on the profile, stating why the grade could not be reduced, and, where it is possible to change the location, a survey should be made showing the possibility of such work, and the per cent of grade must be noted on the profile.

Type of Survey.—When a survey is to be made in sidehill country it will be necessary to secure all data from which to figure all quantities required for the engineer's estimate, besides giving the State Inspector the informtaion necessary to enable him to direct the progress of the work. This applies to all new work, whether following old roadbed or making a relocation. This will require a careful alignment survey and detailed cross-section and profile.

When a grading operation is contemplated and the amount of earthwork is very light, which would mean 1 ft. of excavation or such would have to be made at different points, or where slight elevations are to be moved to fill slight depressions nearby, and, if in the opinion of the engineer it would be advisable to receive bids on the mile basis, it may be necessary to supplement the line survey by only such staking as will serve to indicate the location and grade of the work to be done.

The least survey will probably be required when the work to be done consists of resurfacing a road which is already shaped and at the proper grade, and whose course is well defined. In this case, it may be necessary only to run such a general line survey and profile to show the existing grades and to secure such additional data as the width of the existing right of way, the width of the roadbed in cuts and on fills, and take occasional cross-sections to show the condition of present road. Also dig a few test pits to show thickness of stone and show condition of the culverts as will enable the Commissioner to determine that the situation is such that state funds may be expended properly on the road.

On resurfacing work the engineer should at the outset send to the central office all information about drainage structures. Such procedure will allow designs to be made while the engineer is making surveys and maps, and when same are sent to the office the designs can be attached to plans, blue printed and contracts for everything let at one time.

Surveys.

The final location should be made in the field and not on paper, and sufficient data must be secured to enable the computation of all quantities, and such stakes should be set as will be necessary for the State Inspector in giving all the lines and grades which will be necessary during construction.

Survey should consist of the running of the center line, marking the location of the necessary objects along the road, and setting the stakes and marking to designate line and grade; running levels and taking cross-sections; and securing such information on bridges and culverts and the general drainage situation as may be required.

Survey Line.—The final survey line is to be the actual construction center. If preliminary lines are necessary, the center line is to be located after plans are drawn. The angle points should, if possible, be located on the nearest 1/10 footmarks and the deflection angle for each course should be measured to the nearest minute, and the magnetic bearing of each course must be taken and indicated on the plans. Every angle point should be referenced in with three ties to permanent objects unless the courses are very short. All curves should be run in the field at the time of making location. On resurfacing work it is not necessary to run curves, but angle points should be referenced about every 1,000 ft.

Side Locations.—In general, a tape survey will give the necessary accuracy in making locations. All significant objects within 100 ft. or so of the finished road should be indicated, but where they are at a greater distance the dimensions, etc., may be estimated. Whenever the position of an object becomes important (as, for instance, when a stream nears the road embankment or when a house is situated close to a road whose grade it is planned to change to a marked degree), locations should be made to the nearest foot.

Offsets from the survey line to the bordering fences or walls should be made every 100 ft., or oftener if the irregularities so require; dividing property fences should be located by offsets from the center line, but the direction may be satisfactorily indicated by determining their range intersection with the base line; and when it becomes necessary to locate buildings or other objects accurately it will be sufficient to determine their range on the base line and their rectangular dimensions. Location of materials, quarries, gravel beds, etc., should be taken, and it should also be noted where water may be obtained for sprinkling the roads.

Alternative Lines.—In case the engineer is undecided which of two possible relocation lines should be followed, he should run a line from each location, these lines to be designated "Line A" and "Line B." Profiles and cross-sections should be taken along each line and plans of both sumbitted to the State office with reasons for selection of the route adopted and an estimate of the cost of each also to be furnished.

Alternative lines should be made on separate sheets.

Levels.—Profile levels should be taken at least 300 ft. beyond the beginning and end of the proposed road.

A well-adjusted transit-bubble will be sufficiently accurate for general highway work where a closing error of 1/10 ft. per mile will be allowed.

Levels should be run forward and backward along the course of the road in order to close the circuit. Bench marks on some prominent object should be taken at intervals of each ¼ mile and recorded in the notes.

The profile levels of the center line and bench marks should be run in one operation and check levels run in the same operation with the cross-sections, but do not attempt to do both at one operation.

It is not necessary to run check levels on resurfacing work.

Cross-Sections.—Cross-sections should be taken at all 100-ft. stations in regular country and at shorter intervals where the ground undergoes a marked change between stations. Where rock is encountered, sections and soundings to determine the elevation of the rock should be taken at such frequent intervals as the surface requires.

At the station points readings should be taken on the center line of the traveled way, the right and left edges of the traveled way or of the roadway, at the top and base of each slope, and one reading farther out (not less than 30 ft. from the center line of location) at either side to show the slope of the natural surface.

Readings on the ground should be taken at the nearest 1/10 ft.

In general, it will not be necessary to show more of the topography than these cross-sections will reveal. In cases where the location of the road is open for some question, a short topographic survey might be made in order to show on the plans the circumstances which caused the choice of the location to be made.

Take only a few cross-sections to show condition of road on resurfacing work.

Drainage.—Complete provisions must be made for the drainage of every road, and the plans must show what arrangements have been made and complete data must be furnished for all drainage structures larger than regular standard culverts. Estimates of the drainage area for all structures must be given in all cases.

For culverts the length, width and average slope per 100 ft. of drainage area should be noted and the direction of flow indicated on plan by an arrow.

Ditches.—Whenever the road is at a grade of less than 5 per cent, the grading of the drainage ditches must be planned by a separate grade. The design of the ditch must be shown on the cross-sections, and all grades of less than 0.5 per cent should be avoided if possible.

Underdrains.—The engineer should take special care to note or to determine by local inquiry any parts of the road which break up in wet seasons and specify underdrains.

Culverts.—Pipe culverts crossing the center line of the road should not be less than 22 ft. long.

Every bridge and culvert within the course of the design should be described in the specified form whether it is or is not intended for reconstruction.

At every culvert which it is proposed to construct or reconstruct a cross-section should be taken along the proposed axis, and the section taken far enough out to show elevation of inlet and the lowest possible outlet available, even if this involves the construction of a short ditch.

Profiles must also be taken on the center line of the road, the elevation of the finished roadway noted, and, if the culvert is to be located on a skew, the angle of the skew must be given. Do not try to build culverts at right angles to the road if same should be built on a skew to fit the stream.

Considerable attention should be paid to the angle at which any drainage structure crosses the road, and, if they should be built on a skew, these angles must be noted and the length and type of wings should be noted in every instance. Culverts should not be designed askew if possible to economically change the course of stream.

Data Sheet.

In addition to the plans, cross-sections and profiles, an extra sheet or two should be added for showing any data with which it is not desired to encumber the plans, such as showing the details of any structure which requires dimensioning for showing the total amount of each class of work required; for showing the profiles, etc., of new drainage structures, and for giving the information necessary for inspectors when they are required to take the work without further aid.

These sheets may either be plain or ruled with cross-section or profile ruling.

Details should be shown on a scale of 1 in. equals 50 ft. or less. Special details should be shown on a scale of 1 in. equals 4 ft. Instead of detail drawings for concrete culverts, the overall length may be specified, and for the various sizes reference to be made to the standard drawings of the Department of Public Roads. The lengths of all other types of culverts as well as size must be shown.

Quantity Sheet.

It will be necessary to prepare a summary sheet showing by stations all information pertaining to the road. Quantities like the amount of macadam required for different points of resurfacing job should be noted. The lineal feet of shaping may or may not require listing, depending on whether or not the same is uniform throughout the course. The quantities such as excavation fill, and the yardage of retaining walls and drainage structures must be shown.

A suggestion for an orderly form showing the data necessary to enable the inspector to stake out the work and make an estimate is given below:

Sta.	Distance to center line. Right Stake.	Distance to center line. Left Stake.	Cut or fill at center line. Right Stake.	Cut or fill at center line. Left Stake.	Excavation cu. yd.	Over haul.	Rock, cu.yd.	Walls, Etc., cu.yd.
0..........	21.3	18.6	C-3.2	C-6.2	...	..	10	..
1..........	16.4	21.3	C-1.0	C-2.4	100	..	..	..
2..........	17.0	15.8	F-5.1	C-0.0	50	50	..	18

Culverts.

Sta.	Size.	Overall length.	Concrete cu. yd.	Steel pounds.
1 plus 20..........	6′x4′	20′	20.7	1,215
3 plus 45..........	3′x2′	18′	9.0	.493

Estimates.

The estimate in quadruplicate of the cost of the road which accompanies the plans should be made on an 8½x11 white paper sheet. Such estimates are to be approved by the Division Engineer and sent to the State office for final approval, and same should accompany the plans.

This estimate should consist simply of a statement of a list of the total of each class of work which is required, with the estimated unit price for each class and the product of these two figures, thus:

Quantity.	Item.	Unit price.	Cost.
62.1 cu. yd.	1:2:4 concrete	$8.00	$ 496.80
1000. cu. yd.	macadam	1.20	1,200.00
			Etc.
Total cost of items			$26,000.00

To approximate the total cost to the county, there should be added to the total of all items so obtained an amount equal to 20 per cent, to make ample provision for contractor's profit, and an amount equal to 5 per cent, to allow for the supervision of the work, thus:

Total cost of items	$26,000.00
Add 20% allowance to include profit	5,200.00
Add 5% allowance for contingencies and supervision	1,300.00
Total approximate cost to county	$32,500.00

In order to enable the Department to consider the estimates of cost, it will be necessary to explain the way in which the unit prices are derived. This will not be necessary for such items as excavation, but whenever a unit cost is derived by taking the sum of its component costs, as would be the case with concrete in place (which includes the price and cost of hauling cement, gravel, sand and stone, cost of forms, cost of mixing and placing concrete, tearing down forms and cleaning up), the derivation of that unit cost must be shown. Such information may be placed on the back of the estimate sheet, and, unless they are so shown, the approval of the plans may be delayed at the Central office.

In case of macadam or gravel surfacing the derivation of the cost should also be shown. Some common derivations are given below merely as a guide.

Macadam.

In estimating the cost of macadam the engineer should state where the stone is to be obtained—whether from the bins, from the cars, or whether it is to be crushed by the contractor.

A typical detailed cost should show:

Cost of stone at quarry per ton
Freight to siding, per ton ....
Multiply by 9/7 to get cost per cu. yd.
Unloading from cars to wagon at 10 ct. per cu. yd.
Hauling ( ) miles* at 25 ct. per mile
Handling (including watering and rolling at 20 ct. per cu. yd.) ....
Multiply by 4/3 to allow for compacting
Total cost per cu. yd. for macadam in place ....

For quarry stone crushed by the contractor, the components preceding that for hauling would consist of:

Price in ledge per cu. yd. ....
Stripping per cu. yd. ....
Quarrying per cu. yd. ....
Crushing per cu. yd. ....

For field stone crushed by the contractor, the components preceding the cost of crushing would consist of only:

Stone delivered at crusher ....

Concrete.

In estimating the cost for concrete the total amount of each class should be determined, and the cost for each class determined somewhat as follows:

Concrete—Class A, 1:2:4—

1.57 bbl. cement
.44 cu. yd. sand
.88 cu. yd. stone.
See "Standard Specifications for Bridges, etc."

Cement.

Cost per bbl. at town.
Hauling* ( ) miles at 5 ct. per mile
Cost per barrel ....
Cost for 1.57 barrels ....

*Take distance to midway point of construction.

Sand.

Cost at bed, per cu. yd.
Hauling† ( ) miles at 30 ct. per mile.
Cost per cu. yd. ....
Cost for .44 cu. yd. ....

Stone.

Cost per cu. yd. loose (same as macadam detail as far as hauling) ....
Cost for .88 cu. yd. ....
Mixing, per cu. yd. ($1.50)
Form work, per cu. yd. ($2.00) ....
Total cost per cu. yd. in place ....

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†Take a distance for a point which is an average for all culverts on the work.

Road and Bridge Construction in Iowa During Past Four Years

Since 1913 the State of Iowa has consistently followed a program of draining, grading and permanently bridging its highway. The results obtained in this work were summarized by Mr. Thos. H. MacDonald, Chief Engineer State Highway Commission, in a paper presented last August before the convention of the State Association of County Supervisors, from which the matter following is taken.

At the close of 1916, 7,530 miles, or approximately 50 per cent of the county road system, had been built to a natural grade. This represents for the most part, the work accomplished by the tractor and blade grader crews in grading the roads to standard cross section, but without any considerable grade reduction. In all 1,506 miles had been built to permanent grades in accordance with standard cross sections, and 535 miles had been surfaced. With the exception of a very few miles, this surfacing has consisted of one-course gravel about 10 ft. wide, conforming to the Class B specifications, which requires approximately 880 cu. yd. of gravel per mile. This is the minimum surfacing improvement which the Commission after a thorough examination of the gravel roads which have been built, could specify when providing standard plans and specifications for the use of the counties. During 1916, 625 miles of earth roads were built to permanent grades and standard sections, 107 miles were built to temporary grades, 3,680 miles were built to natural grades, and 277 miles were surfaced. Considering the expenditure of the county road funds, 40 per cent was expended for permanent work, 16.5 per cent for temporary work, 16.6 per cent for repairs, 11.9 per cent for maintenance, 7.4 per cent for equipment and unused material, and 7.6 per cent for miscellaneous work. It will be seen at once that no part of this program is open to the criticism of extravagance or of providing a class of roads that is not demanded by the traffic. Even those who criticise Iowa's lack of surfaced roads, freely admit that Iowa is laying the foundation for any system of roads she might in the future wish to build, by the grading and drainage of the earth roads, which is now being carried forward.

The expenditure during 1916 for permanent bridges and culverts was 59.3 per cent of the total, for temporary bridges and culverts 18.1 per cent, repair work 15.1 per cent, and miscellaneous 7.5 per cent. Here again there has been consistently followed during the years 1914, 1915 and 1916 the policy of expending as great a proportion as possible of the bridge funds for permanent work. In 1914 the percentage for permanent work was 53 per cent; in 1915, 61.6 per cent, and in 1916, 59.3 per cent. This sound policy will eventually bring the same result for the whole state that it has for the individual counties; that is, a reduction of the bridge taxes. Story County, which has pursued the policy of building as many permanent structures as possible, for a period dating back of the present road laws, has reduced the bridge tax from a maximum of 5 mills to 3½ mills, and yet has sufficient funds to replace with permanent structures the bridges which must be renewed from year to year. It is true that some counties have reduced their bridge tax arbitrarily when additional funds were seriously needed to keep their bridges from deteriorating, but such a policy is neither wise nor economical to the taxpayers. This is not the case in Story County, which is given as an example of a number of counties which have pursued the same policy, for this county has reached the point where the number of bridges which must be replaced each year is definitely decreasing.

Even though prices of material and labor are increasing and are more difficult to obtain, there is nothing to justify the expenditure of a greater percentage of the bridge funds of the state on temporary forms of construction. Even at the advanced costs, permanent bridge construction is the most economical to use. Unquestionably there are those counties which cannot choose and which, because of the large number of bridges requiring replacement, must resort to temporary construction. All the structures that can be made to serve for a number of years by proper repairs, should be so repaired, and where the construction of large bridges can be deferred, this should be done, but for the majority of the counties, where it is necessary to replace bridges on improved roads, permanent construction should be used. The state average for the past three years, of not less than 60 per cent of the bridge funds for permanent work, must be maintained.

Viewing road and bridge building for the past four years in the light of present prices, there is no place where it appears that a more fundamental or economical program could have been formulated and followed. It is not open to the criticism of extravagance. It is rapidly developing to give service to the people of the State as a whole, and there is no important change which should be made in the established program as a logical result of the present situation.

Prison Labor on County Road Work in Ohio

Short-term prisoners from the county jail are being used by Mahoning County, Ohio, on road construction. The prisoners are worked in gangs of from 10 to 20 men under the care of guards, one guard being assigned to approximately every 10 men. These guards are chosen from men who are experienced in road construction and are placed in charge of both men and work. In this way the failure of co-operation between the guards and foremen, that has been experienced in other localities, is overcome. The prisoners are worked without shackles and with as little show of restraint as possible. Consequently, to the casual traveler, the gangs are not to be distinguished from free laborers.

The results of the experiment, according to Mr. Ett S. Smith, County Surveyor, have been highly gratifying and at the same time profitable. It is claimed the men do a better day's work than most of the hired gangs and there is no trouble in keeping the gang full as the jail inmates are anxious for the jailer to assign them to the road gangs and frequently request that they be sent out. As to escapes they are very rare. Naturally some are to be expected, but those who do escape are generally picked up and resentenced. While on the road gang each man is credited with $1.50 per day toward paying his fine and costs and upon completion of his term he is given a job on one of the hired gangs if he so desires.

The prisoners have constructed two township ditches of a total length of about 1 mile; have resurfaced with a 4-in. waterbound macadam top about 10 miles of road; have built, including grading, about 1 mile of new improved road and have resurfaced with bituminous treatment and screenings about 16 miles. Besides this they have ditched a number of roads, shaped berms, excavated for and laid culvert pipes and performed other work.

Mr. Smith states that under this plan the county road department has been able, notwithstanding the present labor conditions, to accomplish more work this year than at any other time.

The Cleveland Plan for Assessing Repaving Costs

The city of Cleveland, O., has had in successful operation for the last four years an interesting plan for the assessment of costs for repaving. Under this plan original paving is paid for by 98 per cent assessment against abutting property, while the city pays 2 per cent plus intersections. For repaving within a limited period, the apportionment is 50 per cent to the property owner and 50 per cent plus intersections to the city.

When a new piece of work is authorized, the legislation for it contains an estimate by the Director of Service of the life of that particular improvement. If it has to be replaced before the end of the time named, it is considered a repaving job and is paid for on the 50-50 basis. If, however, it lasts the specified period or longer, a replacement is treated as an original improvement and may be assessed 98 per cent against the property.

The section of the charter regarding this particular feature follows:

> Section 161. Every ordinance passed subsequent to the adoption of this character, providing for an improvement to be paid for in whole or in part by special assessments, shall contain an estimate by the Director of Public Service of the life of the proposed improvement. Any assessments thereafter made for replacing such improvement within such estimated period of life shall be limited to a sum not in excess of 50 per cent of the cost of such replacement. Assessments for replacements at or after the expiration of such estimated period of life shall be subject to no limitation except as provided for assessments for original improvements.

The charter containing the above provision was adopted in 1913. Since the provision would affect only those streets which were paved after the charter went into effect, another section was inserted to cover the replacing of existing improvements. This provided that any assessment for such replacement in less than 15 years from the date of a prior assessment for the improvement to be replaced, shall be limited to a sum not in excess of 50 per cent of the cost of such replacement.

Labor Saving Sand and Gravel Plant

A labor saving outfit designed for excavating sand or gravel from banks has been placed on the market by the Ideal Engine Co., 615 E. Kalamazoo St. Lansing, Mich. The material is excavated by scrapers suspended from a cable, and so arranged that while one scraper is digging the other is discharging its load into a bin, from whence the material can be loaded direct into wagons or conveyed by chain buckets to screens. The power for operating the scrapers is obtained from a 2-drum hoisting machine driven by an 8-hp. engine. The only manual labor required in excavating is one man to operate the hoist levers.

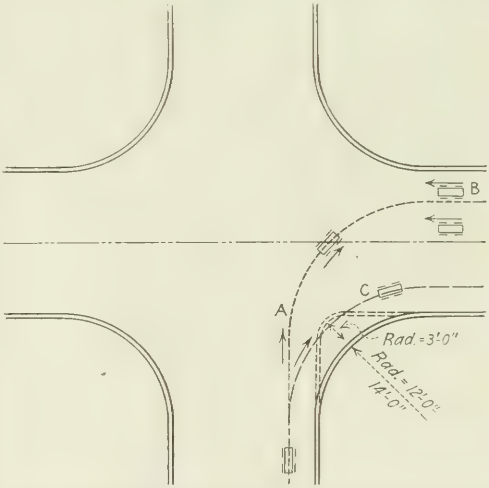
Increased Radius of Curb at Street Intersections Makes for Quicker and Safer Turns

Street intersections are too commonly laid out with little thought of the change that has come about in vehicular traffic. Slightly rounded corners, once satisfactory, do not now make for convenience and safety. In the time of slow-moving horse-drawn buggies and wagons of short wheel base they were satisfactory, but they do not meet the needs of motor traffic.

The accompanying illustration shows the intersection of Lake Shore Drive and Division St., Chicago, where the original 1½-ft. radius curb has been replaced by one of about 14-ft. radius. The old curb had not yet been removed. The distance from the old corner to the new is 7 ft. on one corner and on the other 5 ft.

Construction of Long Radius Curve at Intersection of Lake Shore Drive and Division Street, Chicago.

Vehicles turning into Division St. had been forced to swing out into the center of the street or beyond, while the new curb permits a vehicle to make the turn with only slight speed reduction and without passing over the center line of the street.



Sketch Showing Suggested Increase of Radius of Curb at Street Intersections.

The diagram shows this still more clearly. Except at extremely low speed, a vehicle cannot avoid crossing the center of the street in making the turn in the case of the old curb, while the long radius permits it to keep to the right, in accordance with traffic rules.

Suggestions on the Care of Street Department Horses

All district and stable officers, drivers, hostlers and stablemen of the Department of Street Cleaning of New York City, of which Mr. J. T. Fetherston is Commissioner, are furnished with a pamphlet, advising how to prevent sickness of horses, how to determine sickness and what to do for a sick horse. Directions also are given outlining the proper manner in which the stock is to be watered and fed. This pamphlet contains so much useful information that it is reprinted here:

Colics.

Causes.—Colics in many cases are preventable and are chiefly due to improper feeding and careless watering, excessive heat and humidity, long hard hauls and other forms of abuse, such as falls, strains, etc., feeding of new hay and oats or grasses or leaves, and above all the feeding of garbage, a common practice of careless drivers, which causes one of the fatal forms of colic or bowel disorders. Some horses are subject to colics due to internal causes and demand special care in avoiding the frequency of the attacks.

How to Prevent.—To avoid colics all horses should be watered before the feeding of hay, oats or other feed. Water given immediately after the animal has eaten is bound to set up stomach trouble, and one should be careful not to give any water for at least one and a half to two hours after feeding, and then no more than one pailful. A large drink of cold water on a stomach that has been denied water for a very long time is apt to cause colic. A big heavy feed in the middle of a hot day is another great cause of colics. Frequent watering of the horse during the day will go a great ways to prevent sickness, and if the animal is given on an average of at least a half-dozen drinks or more during the working hours, as water cannot be offered too often, drivers will find their horses perform the work better, and that colics and other horse ills will be very unusual.

Hostlers, stablemen, drivers and others should make it a rule to give every horse under their charge all the water it wants in the morning before feeding, and under no circumstances allow the horse any water immediately after feeding. The same rule should be followed in regard to the noon and evening meal. Permit the animal to drink one pail of water after the first load is dumped and then an ample drink to be given after the dumping of every load. If the horse is watered in the above described manner there is absolutely no danger of any harm being done even if he is very warm, because one can readily understand that by frequent watering the animal will never drink to excess at any time, hence the danger is reduced to a minimum.

When the horse arrives at the stable at the end of the day's work, if the driver has been honest with his horse and has given him water as often as outlined, he may lead it, warm or otherwise, to the trough and permit it to partake of another drink before entering the stall. But if the driver has been unable to give the horse its supply of water during the working hours, he must be cautious and not allow it more than a half-dozen swallows of water which will hasten the cooling process, and when the animal has been cooled off properly it may have an unstinted supply of water, but same must be given before any hay, oats or other feed.

Watering the horse during the early part of the if the horse had had a sufficient supply during the day when it is needed the most. Water given during the night interferes with the digestion of the large bellyful of hay and oats which the animal has eaten earlier in night is extremely dangerous and really unnecessary the evening. Therefore avoid giving the horse water until morning, and then as herein described.

Feeding a large meal in the middle of a hot day often does great harm, and it would be better to cut the allowance in half, or in fact in some cases the horse would do better without any dinner. Trotting a horse immediately after feeding or drinking will cause indigestion and scouring, and will tend to bring about heat exhaustion and colics.

How to Tell.—Symptoms of colic are very plain. The animal paws with the front feet, raises hind feet to kick at stomach, stretches out, humps up its back, lies down and rolls, looking at either side of its body, sweats freely and often its belly increases in size rapidly.

What to Do.—When a driver notices these signs he must notify his stable at once before moving the horse any further, and await instructions from those in charge of the stable.

Azoturia.

Causes.—Azoturia or so-called Spinal Meningitis is a disease which attacks only those horses that are in the very best physical condition, and there is absolutely no excuse for any horse developing this disease. When a horse is attacked by Azoturia it is usually due to downright carelessness on the part of the attendants or misleading advice as to the method of prevention.

Prevention of this most fatal disease lies in restricting the diet, and at the same time allowing the horse sufficient exercise. Any horse in good physical condition that is suddenly allowed one or more days' idleness is apt to develop an attack of Azoturia when its diet or feed has not been reduced, nor the animal exercised accordingly..

How to Prevent.—Horses in good physical condition that are allowed to stand in stable on account of holidays, lack of work, rest, shoeing, sore necks, breasts, or backs, lameness, etc., or any cause of a non-debilitating character, must be promptly placed on a sloppy bran mash diet of 3 quarts to which is added 2 to 3 ounces of salt. This bran mash to be given only in the morning and evening. No noon meal. In addition to the above ration the animal is allowed not more than 5 lb. of hay, and that to be given only at night. Regarding exercise, 15 minutes' walking is not sufficient for the majority of horses; they must be exercised thoroughly every day and stirred up until they appear warm and have emptied themselves of manure. In such cases where the animals cannot be exercised, owing to lameness, etc., they must be physicked out properly before preparing them for work. In fact, any horse while under the above conditions of rest that seems to have gained in weight should receive a physic ball.

The idea to be kept in mind is that it is better for a horse in good condition to lose 5 to 10 pounds than to gain one-quarter of a pound when idle. Any time the amount of nutrition exceeds the amount of waste in the horse at rest, it will predispose him, without doubt, to an attack of Azoturia.

If one is careful in dieting, exercising and physicking the horse in fine condition, during a sudden period of idleness, even if it is only a half day, Azoturia will be a strange disease in that stable.

Any variation in the above system of prevention in the individual horse must not be made until the attending Veterinarian is consulted.

How to Tell.—Symptoms of Azoturia develop in a horse that has been given a sudden rest ranging anyways from a half day or more; it may show the signs during the exercising or shortly after leaving the stable for work. The horse feels very fresh and spirited, when it suddenly shows, as a rule, a slight lameness or knuckling of one hind leg, giving the driver the impression that the horse picked up a nail or wrenched its ankle. The animal is perspiring freely, and it may, at first, look like an attack of colic. If it becomes excited or the driver continues on his way the lameness becomes intensified, the hind-quarter falling lower at each step, until finally the animal falls, with either or both legs affected, and as a rule is unable to rise.

What to Do.—The time for the driver act is at the first sign of lameness or knucking of either hind leg. He must stop promptly where he is, unhook the horse, keeping it perfectly quiet, and under no circumstances attempt to walk the horse any further either to the stable or elsewhere. He must notify the stable at once and wait until the officers in charge procure an ambulance or other vehicle to take the animal home, no matter how slight the attack appears. Many horses can be saved if the driver is on the alert and does not attempt to push the horse any further; in fact, after the animal has been unhooked it may be at ease and show no excitement, and in such cases it would be just as well to delay, for a while, in moving the horse by ambulance or otherwise, because leading him into the conveyance may bring about another fit of excitement which in turn will aggravate the disease.

Sunstroke, Heat-Stroke or Heat Exhaustion.

Causes.—In medicine there is a difference between sunstroke and heat-stroke, but for the drivers, hostlers, stablemen and others concerned, it is not necessary to outline the two conditions separately, but class them as one disease.

There are many horses that are classified as "Poor Heat Horses" on account of their inability to stand the hot weather. Animals of this type must be worked very cautiously during a hot spell, and whenever possible should be kept at rest during the hottest time of the day. It would be safer for such horses to be worked at night.

Lack of water, heavy feeding, overloading, long hard hauls, trotting under the hot sun or on a hot humid day will cause heat-stroke.

How to Prevent.—Frequent watering administered in the manner described under the heading of "Colics" will tend to prevent attacks of heat-stroke.

To prevent heat-stroke, those in charge of the horse should sponge the head with cold water often, keep the animal in the shade as much as possible, feed and rest him under the same condition, water him frequently during the working hours, and allow cold water to run on his head whenever he seems to blow too much. During a very hot spell the careful attendant will reduce the heavy noon meal of the horse and allow it a rest of two hours at the same time.

Never shower the heated animal's body with cold water because the shock from same will stop the glands of the skin from performing their proper functions in getting rid of the excessive heat that is within the system; water on the animal's body tends to interfere with the perspiration, through which the blood gives off the great heat. Horses that do not sweat, blow hard, and are ready subjects for heat-stroke, because the principal route for getting rid of the increased heat is shut off. Therefore in those cases, by placing the horse in a shady spot and blanketing him, the sweat glands are encouraged to work, and in this way the temperature of the body is reduced. In addition, cold water or cracked ice can be applied to the top of head and well into the rectum or under the flanks in the region of the large blood vessels. It is not advisable to shower the body with cold water not only for reasons explained above, but also on account of the danger of causing Founder or Laminitis. Other forms of heat-stroke that show a skin wet with perspiration do not require blanketing, but are entitled to shade, with cold water or ice applications to head, rectum and under flanks.

It must be remembered that sponging the horse's body with cold water after he has cooled out thoroughly, is not only refreshing but very invigorating if the skin is properly scraped after the sponging.

During the hot summer the stable must have perfect ventilation, and those in charge at night must keep a close watch for any horses that show signs of depression in the stall, because if such animals are overlooked they will surely succumb to the intense heat of the following day, if put to work.

How to Tell.—The symptoms of sun or heat-stroke sometimes appear suddenly, animal may stagger and fall either unconscious or in a delirium, with or without bloating. Cold perspiration may appear in small patches on the skin and the breathing is very noisy; or the horse may require urging before the driver notices that there is a weakness of the gait with very rapid breathing or blowing. Ofttimes the skin is dry and free from perspiration, animal staggers, nostrils dilated, eyes bloodshot, heart pounds swiftly against the chest wall, body trembles, and animal finally falls, often making ineffectual efforts to rise, and its mouth and tongue are very hot to the touch.

What to Do.—Driving on a hot day the careful driver will be very watchful of his horse in trying to save him from severe attacks of heat-stroke by keeping him in the shade whenever possible, watering, feeding and resting him properly, never trotting or abusing the animal, and as the first indication of suffering from the heat will stop and unhook the horse, place it in the shade, and promptly apply cold applications to the head, etc. He must notify his stable at once and not move the animal until ordered by the proper officers.

Injuries, Lameness and Other Ailments.

If a horse goes lame from a fall, or if it shows a sudden lameness, the driver must unhook the animal and examine its foot for nails, etc. If possible he should report the lameness to the officer of the district and promptly notify the stable for instructions. The drivers, hostlers and stablemen must report to the stable foreman, or others in charge, all sore backs, necks, or breasts, scratches, sore ankles or fetlocks, lameness however slight, wounds, cuts, accidents, falls and injuries that happen or develop in the horse while at work or in the stable; also any change in the animal's disposition, such as drooping of head, weakness, dulness, coughing, blowing, off feed or drink, condition of manure and urine; in fact, anything the driver or stable employe may notice out of the ordinary in the horse under his care.

All dumps will be supplied with a first-aid outfit of surgical dressing, to dress cuts, wounds or injuries that may occur to the horse at or near the dumps. The officers at the stable must instruct the drivers how to apply the dressings and bandages.

Bids Asked

Roads = Streets

Ark., Little Rock—Until 10 a. m., Oct. 10, by the Mayor, for 40,000 sq. yds. asphalt or concrete paving for Street Improvement District No. 261. Lund and Hill, 527 Southern Trust Bldg., Little Rock, Ark., Architects.

Cal., Modesto—Until Oct. 9, by H. Benson, Clerk, Stanislaus County, for constructing 16.67 miles of concrete pavement, 2.28 miles, Hickman-Thalheim Road, 8.22 miles Waterford Road, and 5.57 miles on Oakdale-Waterford Road.

Cal., Visalia—Until 2 p. m., Oct. 5, by Board of Supervisors, Tulare County, for improving four sections of county highway as follows: 8 miles, Exeter-Merryman Highway, 10 miles Dinuba-Kingsburg Highway, 7 miles Tulare-Paige Highway and 11.5 miles Portervile-Woodville Highway.

Fla., Pensacola—Until Oct. 8 (re-advertisement) by Bureau of Yards and Docks, Treasury Department, Washington, D. C., for constructing concrete road and culvert.

Fla., Tallahassee—Until Oct. 13, by B. E. Reed, County Engineer, for constructing six miles of Woodville Road, and four miles of Chaires and Capitola Road, extension to Jefferson County line, 4 miles, sand clay.

Fla., Tampa—Until 11 a. m., Oct. 16, by J. G. Yeats, Chairman, Board of County Commissioners, Hillsborough County, for constructing approximately fifty-four miles of hard surface roads.

Ida., Nez Perce—Until Oct. 8 by County Commissioners for constructing 8,500 ft. of 16-ft. highway known as Nez Perce-Green Creek Highway.

Ill., Custerpark—Until 2 p. m., Oct. 6, by B. T. Yeates, Highway Commissioner, Custer Twp., for constructing 1,800 ft. of macadam road in the northeast ¼ of Section 19 known as the River Road.

Ill., Mendota—Until Oct. 8, by Board of Local Improvements, for paving several streets with brick on 5-in. concrete foundation and cement grout filler. Total estimated cost, $36,100. C. Wedner, City Clerk.

Ind., Indianapolis—Until 10 a. m., Oct. 8, by Board of Public Works, for paving Julian. Spencer to Hawthorne, constructing sidewalks on Julian, Spencer, North Side and Butler, South Side to Hawthorne.

Ia., Des Moines—Until Oct. 8 (re-advertisement) by City Clerk for paving Beaver Ave.

Ia., Dubuque—Until 8 p. m., Oct. 4, by J. J. Shea, City Recorder, for improving Cora St., involving 1,970 sq. yds. of macadam, 1,355 lineal ft. of cement curb and gutter, 130 sq. ft. of cement gutter, 220 cubic yds. of filling, and 1,480 cu. yds. of cutting.

Ky., Pikeville—Until Nov. 5, by City Clerk, for paving streets. Estimated cost, $30,000.

Minn., St. Paul—Until 10:30 a. m., Oct. 8, by H. W. Austin, Purchasing Agent, for grading Clifford Ave., Mackubin St., Ivy St., and Mount Curve Blvd.

Mich., Grosse Pointe Park—Until 8:30 p. m., Oct. 11, by Village Clerk, Village Hall, Jefferson and Beaconfield Aves., for furnishing material and paving Wayburn Ave. with brick. Thomas M. Campau, Village Engineer.

Minn., St. Paul—Until 10:30 a. m., Oct. 8, by H. W. Austin, Purchasing Agent, for grading Mount Curve Blvd., alley in Block 2, Merriam's Fifth addition, Ivy St., grading and improving Carbon St., grading Mackubia St., grading and improving Ames Ave., and Alley in Block 3, Roblyn Park.

Minn., St. Paul—Until 10:30 a. m., Oct. 8, by H. W. Austin, Purchasing Agent, City Hall, for furnishing material and grading Clifford Ave., from St. Anthony to Columbus Ave.

Minn., St. Paul—Until 10:30 a. m., Oct. 15, by H. W. Austin, Purchasing Agent, City Hall, for furnishing material and grading alley in H. M. Ranney's sub-division Block 101, Lyman Dayton's Addition; [illegible] Kent St., grading and curbing Greenwood Ave., grading Bison Ave., Sue St., graveling Tatum Ave., grading alley in subdivision of Block 28, Arling Hills Addition; grading Vance St., grading alleys in Block 52, Desnoyer Park, grading Hawthorne St., Hartford Ave., Hillis Ave., and curbing Maryland St.

Mo., Maryville—Until 7:30 p. m., Oct. 5, by Board of Aldermen, for constructing cement sidewalks. E. J. Howland, City Clerk.

Neb., Wahoo—Until noon, Oct. 5, by Joseph B. Hines, County Clerk, Saunders County, Court House, for grading approximately 5,000 ft. road, involving 19,000 yds. earthwork. Total estimated cost, $3,800.

N. J., Newark—Until 3:30 p. m., Oct. 4, by Board of Street and Water Commissioners for furnishing material and paving Bay Ave., involving 10,200 sq. yds. of old granite block pavement with new cinder filler and laid on the present cinder embankment as a foundation, 9,000 lin. ft. quarry cut bluestone header set without concrete to be not less than 16 ins. deep by 4 ins. wide. M. R. Sherrerd, Chief Engineer.

N. J., Paterson—Until Oct. 24, by Board of Freeholders, Passaic County, for improving 2½ miles of Union Ave. G. Ferguson, County Engineer.

N. Y., Yorkville—Until noon, Oct. 9, by W. W. Wotherspoon, Superintendent of Public Works, Capital Bldg., Albany, N. Y., for constructing approaches for foot and vehicular traffic on the south side of Erie Canal to the bridge, also grading and paving same.

Ohio, Cleveland—Until noon, Oct. 10, by Commissioner of Purchases and Supplies, 305 City Hall, for paving, draining and improving Edgewater Cliff Boulevard with bitulithic wearing surface on concrete base or with 4-in. brick on concrete base built monolithic.

Ohio, Cleveland—Until noon, Oct. 10, by Commissioner of Purchases and Supplies, 305 City Hall, for surfacing West Boulevard from Lake to Clinton Blvd., with bitulithic or asphaltic cement wearing surface.

Ohio, Cleveland—Until noon, Oct. 10, by Commissioner of Purchases and Supplies, Room 219 City Hall, for grading, draining, curbing and paving and improving West 82nd St. and grading, draining and improving West 105th St.

Ohio, Columbus—Until 2 p. m., Oct. 12, by Clinton Cowen, State Highway Commissioner, for improving Dayton-Greenville Road in Darke County, in Neave, Greenville and Van Buren Twps. by grading roadway, constructing bridges and culverts and paving with concrete; pavement 16 ft. wide and roadway 26 ft. wide, 2.63 miles in length. Total estimated cost of construction, $66,181.

Ohio, Columbus—Until 2 p. m., Oct. 4, by Clinton Cowen, State Highway Commissioner for improving Section M and O of the Columbus Sandusky Road in Franklin County, Clinton Twp., by repairing culverts, grading roadway and paving with brick on a concrete foundation, 21.5 ft. of pavement, 26.5-ft. roadway, 1,198 ft. in length. Total estimated cost, $10,356.

O., Germantown—Until noon, Oct. 10, by Chester A. Eby, Clerk, Village Council, for furnishing material and constructing combined curb and gutter and paving roadway with Tarvia bound macadam or its equal on West Market St. (Advertisement in this issue.)

Ohio, Lakewood—Until noon, Oct. 8, by Wm. Bayne, Director of Public Service, for furnishing material and constructing sidewalk in Carabell Ave., grading and sidewalks in Hilliard Ave.

Ohio, Williamsburg—Until 2 p. m., Oct. 5, by Village Council at the Mayor's Office, for furnishing material and constructing concrete sidewalks in village.

Ohio, Woodstock—Until 3 p. m., Oct. 6, by Rush Township Trustees, for grading and constructing sidewalks.

Pa., Butler—Until noon, Oct. 8, by W. Marks Starr, Clerk, County Commissioners, Butler County, for removing old stone curb, redressing and resetting same, removing old flagstone sidewalk and placing new concrete sidewalk along the line of Main St.

Pa., Glassport—Until 7 p. m., Oct. 8, by Borough Council, for repaving Indiana Ave. P. S. McMullen, Borough Engineer.

Pa., Williamsburg—Until 8 p. m., Oct. $, by Frease and Sperling, Borough Engineers, Carl Building, for constructing concrete walks involving approximately 15,000 sq. ft., in borough.

W. Va., Clarksburg—Until 8 p. m., Oct. 12, by L. A. Hess, for paving Stealey St., Holland Ave., Magnolia Road, Traction St., 4th St., Lynn Ave., involving approximately 7,600 sq. yds. brick paving, 6,000 lin. ft. concrete curb. Total estimated cost, $15,000. C. C. Fittro, Engineer, Stealey Heights, Clarksburg, W. Va.

W. Va., Wayne—Until 1 p. m., Oct. 13, by Sam J. Crum, Clerk, County Court of Wayne County, for constructing road at head of Whites Creek in Union District, and constructing two fills on Mill Creek in Butler District.

Wis., West Allis—Until Oct. 6, by City Clerk, for grading Lincoln Ave. and Georte St. E. E. Orbert, City Engineer.

Bridges

Ariz., Leupp—Until 2 p. m., Oct. 25, by Department of Interior, Office of Indian Affairs, Washington, D. C., for furnishing material and constructing two highway bridges.

Cal., Sacramento—Until 2 p. m., Oct. 15, by California Highway Commission, 515 Forum Bldg., Sacramento, for constructing three reinforced concrete bridges across Castle, Mears and Flume Creek, Shasta County, 120 ft., 45 ft. and 30 ft. long, involving 555 cu. yds. Portland cement concrete, Class "A," 241 cu. yds. Portland cement concrete, Class "B," 46,120 lbs. reinforcing steel, hauling and placing, and 240 lin. ft. pipe rail, hauling and placing. Austin B. Fletcher, Highway Engineer.

Cal., Ventura—Until 11 a. m., Oct. 16, by Board of Supervisors, for constructing reinforced concrete culvert on Foothill Road, about 1½ miles east of here, known as Ready culvert, involving 47 cu. yds. Class B concrete, 8 cu. yds. grouted boulders, 2,635 lbs. reinforcing steel, 160 lin. ft. of standard guard fence 20 ft. 30-in. and 18 ft. 24-in. corrugated metal pipe and 340 cu. yds. excavation.

Cal., Ventura—Until 11 a. m., Oct. 16, by Board of Supervisors, for constructing reinforced concrete culvert on Telegraph Road, involving 59 cu. yds. Class B concrete, 2,430 lbs. reinforcing steel, 80 lin. ft. guard fence, 18 ft. 30-in. and 18 ft. 18-in. corrugated metal pipe.

Ga., Oglethorpe—Until 11 a. m., Oct. 10, by F. J. Frederick, Chairman, Commissioners of Macon County, for furnishing material and constructing five reinforced concrete bridges: Beaver Creek, at Montezuma; Buck Creek, near Oglethorpe; Whitewater Creek, near Oglethorpe; Whitewater Creek, at Ideal, and Hog Crawl Creek, near Dooling. Arthur Pew, Consulting Engineer, Forsyth Theater Bldg., Atlanta, Ga.

Ill., Carlyle—Until 1:30 p. m., Oct. 13, by J. T. Goldsmith, County Superintendent of Highways, Carlyle, for constructing reinforced concrete bridge with plain concrete abutments to be built between sections 10 and 15 in Santa Fe Twp., Clinton County, known as Lutz bridge, 16-ft. span, 16-ft. roadway, 7½ ft. overall, involving 46.5 cu. yd. concrete, 2,730 lb. reinforcing steel.

Ill., Marion—Until 9 p. m., Oct. 8, by P. B. Wilson, County Superintendent of Highways, for constructing Dorris, reinforced concrete bridge, between sections 2 and 3 in Lake Creek Twp., Williamson County 35-ft. span, 16-ft. roadway and 17-ft. over all, involving 115.5 cu. yd. concrete and 13.590 lb. reinforcing steel, 491 lb. cast iron rockers and steel plates, 1,700 cu. yd. excavation. Total estimated cost, $3,510.

Ind., Portland—Until 2 p. m., Oct. 6, by John Bonifas, County Auditor, Jay Coun-

Waterworks and Hydraulic Issue
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ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

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What is "Actual Cost" on a Force Account Job?

Many public works contracts provide that any extra work may be done by force account, the contractor receiving "actual cost as estimated by the engineer plus 15 per cent for profit." Comment on such a contract was made by Mr. E. T. Thurston in our last Waterworks and Hydraulics Monthly issue (Sept. 12, p. 211). Mr. Thurston stated that on a certain sewer job the city engineer interpreted the "actual cost" to mean the cost exclusive of general superintendence and plant, when, as a matter of fact, these general expenses totaled 15¼ per cent of the cost of labor and materials. Mr. Thurston said:

> It is a not uncommon notion of engineers and architects that a 15 per cent, or even a 10 per cent, allowance, over and above actual cost of labor and material, is ample to cover general expense and profit on extra work. As a rule extra work imposes on the contractor trouble and expense out of proportion to the average for the job and the fact cannot be too clearly impressed upon the minds of engineers and architects that it is this general annoyance and expense that entitles him to a fair, clear profit over all estimable items of expense entering into the work.

Unfortunately the wording of extra work clauses in contracts is often ambiguous and seldom sufficiently definite as to the meaning of the term "actual cost." If only small tools and no expensive plant are to be used, it is not unusual to specify that remuneration for the interest, depreciation and repair costs on the plant shall be covered by the percentage allowed for profit; but where the investment in the plant is considerable, it is common practice to specify a daily or monthly rental price to be allowed to the contractor for the plant as a whole or for each of the plant units.

General supervision and general office expenses are usually paid for in the percentage allowed for profit, where the job is a large one; but on small jobs the salary of general superintendent is usually included as part of the "actual cost." It is quite important to specify what "overhead" or "general" expenses are to be included in the "actual cost" and what are to be included in the percentage allowed for "profit." Thus, office rent, bookkeeping, and the like, should be specifically included or excluded from the item of "profit."

Mr. Thurston is right in saying that engineers commonly underestimate the items of overhead costs. This is particularly the case on small jobs and where bad weather makes it impracticable to work continuously. Superintendents' salaries and office expenses go on continuously, rain or shine, and often during the interim between the finishing of one contract and the beginning of another. The writer has frequently had fair-sized "profits" wiped out entirely by the overhead expenses during bad weather and the interims between contracts.

Calking Pipe Joints with Air Hammers

In these days of labor scarcity many new uses are being found for old tools and devices. Thus, compressed air hammers have been found economic for calking the joints of cast iron pipe where hand labor would have been employed a few years ago.

It is stated that with a small air compressor driven by an 8-h.p. gasoline engine, two pneumatic hammers will drive home the oakum and lead in 600 ft. of 12-in. pipe per day. The compressor is moved forward at the end of each day's run.

As shown in previous articles, air hammers are tools that are very useful in removing brick pavements and in chipping the mortar or bituminous filler from the bricks after their removal. The same general type of tool is largely used for drilling rock in trench work. Hence there are many water works that should have a small air compressor and its accessory tools.

Waterworks Superintendents Should Learn to Make Bacteriological Tests of Water

The average man, even when well educated, regards a knowledge of bacteriology as an accomplishment possible only by long study and careful technical training in a college. Therefore it will surprise most of our subscribers to learn that any water works superintendent can succcessfully make bacteriological tests after a few days of training under an expert and with the aid of two or three books.

In our last Waterworks and Hydraulics Monthy issue, Mr. Ray C. Werner, Chemist of the Georgia State Board of Health, stated that for every waterworks plant there should be frequent bacterial counts made by some one located at the plant, and that for small plants the superintendent should be the "some one" to do the sampling of the water and the counting of the microbes in it. With a laboratory equipment costing only $125, a superintendent can conduct bacterial counts and tests for B. Coli.

Every conscientious and ambitious waterworks superintendent should follow up this suggestion, for the lives of hundreds of people may be saved by his doing so.

Method and Cost of Rebuilding Filter Beds at Cincinnati Filtration Plant

The filter plant of the city of Cincinnati, O., as placed in operation in 1907, had a strainer system consisting of perforated plates covering concrete channels located at the bottom of trough-like depressions running lengthwise of the filter. The depressions were filled with gravel and to prevent its displacement during washing, wire cloth screens were bolted to the tops of the troughs. These retained the gravel effectively and prevented the passage of sand into the filters. It was found, however, that the screens corroded in the water at Cincinnati, and consequently they were removed, and the necessity for their use avoided by increasing the depth of gravel above the strainers to 14 in. The methods employed in reconstructing these filter beds are described by Mr. J. W. Ellms, Superintendent of Filtration, in the last annual report of the Cincinnati Water Works Department, from which the matter following is abstracted:

Following the experimental work that was undertaken to determine the best plan to pursue in rebuilding the beds after removing the brass wire cloth, one filter, No. 19, was rebuilt and put in service on Dec. 25, 1913. This filter was operated continuously in order to observe its action with the increased depth of the gravel bed (14 in.) that had been substituted for the 7½-in. gravel bed used with the wire cloth screen. The satisfactory results obtained with this filter after operating it for nearly a year, confirmed the conclusions derived from the experiments, and plans were made to rebuild the remaining beds of the plant.

As the handling of the sand by throwing it up to a platform made of plank laid over the top of an adjoining filter, had proven expensive, a centrifugal pump was installed in the middle gallery of the filter house on the motor gallery floor. The pump was capable of throwing 180 gal. of water a minute and would produce a pressure at the pump of 100 lb. per square inch. A sand ejector was purchased and was used to transfer the sand from one bed to another during the reconstruction work. This outfit proved satisfactory, and saved a great deal of the expense of manual labor that would have otherwise been necessary in handling the sand.

Late in the fall of 1914, Filter No. 2 was reconstructed before the sand handling apparatus was installed. The cost of rebuilding this filter, the same as in the case of Filter No. 19, which was rebult during the previous year, was much in excess of the cost of reconstructing the remaining 26 filters of the plant.

On Dec. 16, 1914, active work was commenced on the remaining 26 filters and they were completed on March 9, 1916 The laborers doing this work were the men from the reservoir force, and they carried on all the other work of the plant in conjunction with this work of rebuilding the filter beds. In consequence, they were not employed continuously on the reconstruction work, but gave it as much attention as they were able, in order to complete it as soon as possible.

Substantial screens were built to be used in grading the gravel. These screens were necessary, not only to separate the various sizes of new gravel needed for increasing the depth of the bed, but also to regrade the original gravel removed from the filter tanks. The grading and regrading of the gravel proved, if anything, more expensive than any other part of the work, since handling and rehandling the gravel was unavoidable.

The gravel layers placed in the bed were graded as follows:

Size of separation.	Depth of layer, in.
Passed a 2-in. and retained on a 1-in. screen	2
Passed a 1-in. and retained on a ¾-in. screen	2
Passed a ¾-in. and retained on a ½-in. screen	3
Passed a ½-in. and retained on a ¼-in. screen	4
Passed a ¼-in. screen	3

Thirty inches of sand were placed directly on top of the finest gravel layer. No new sand was used, except about 6 or 7 cu. yd. in the last filter rebuilt. The sand now has an effective size of 0.38 m.m. and a uniformity coefficient of 1.35.

The sand received no cleaning other than what it may have obtained in being transferred from one bed to another. The handling of the sand was so arranged, that the removal of sand from one bed was the operation that transferred it to a reconstructed bed. Two handlings of the sand were thus avoided.

In order not to disturb the gravel, the sand shoveled into the ejector was discharged into a galvanized iron pocket swung between the wash troughs and above the newly laid gravel bed. The velocity of the escaping water was thus reduced, and no disturbance of the gravel resulted. A systematic method for clening the filtered water channels under the brass strainer plates was followed. Plates over the riser pipes were removed, and at the ends of the tank. Caps on the manifold headers under the filters were removed. Any sand that may have gotten down into the effluent piping was flushed back with the wash water out of the open ends of the manifolds. Hose streams were used to wash out the channels under the plates, and any sand in them was washed down the riser pipes and out of the ends of the headers.

Every hole in the strainer plates of each filter was opened up by pushing a sharp piece of steel into it. Any incrustation or lodged sand particles were thus removed. Many hook bolts were replaced that had been broken, either in the course of operation of the filter, or from having been originally strained too hard in placing them in the first place. Any plate that was improperly grouted was repaired, and the plates that had to be removed were carefully cemented back in place.

As the increased depth of the gravel has brought the sand surface nearer the edge of the wash troughs, the wash water valve has had to be reset, so as to give a velocity of wash water of less than 2 ft. per minute. The velocity of wash water is now about 18 in. per minute.

The estimated cost of reconstructing the filter beds was $8,500. Obviously there was not very much exact information on which to base an estimate. The handling of the gravel proved to be the most expensive part of the work. Gravel also cost an average of $1.62 per ton instead of the $1.39 per ton used in the estimate. The actual cost, as nearly as it is possible to get at it, appears to have been $9,502.76. This gives a total cost per filter of $339.38, which is equivalent to a cost of 24.2 ct. per square foot of filter area. There is a credit against the above cost for 150 tons of gravel left over and having a value of $1.62 per ton, or a total of $243. From the sale of old brass wire cloth, there was a saving of the scrap value of 38,125.5 lb., having an estimated value of $3,304.60. Adding these two items together makes a total credit of $3,547.60, which if deducted from $9,-

502.76, leaves a net cost to the city of $5,955.16 for this reconstruction work. This is equivalent to $205.54 per filter, or 15.2 ct. per square foot of filter area.

The cost of the various items was as follows:

Operation.	Quantity.	Hours.	Cost.
Removing old gravel	...	3,936	$ 996.75
Screening old gravel		3,890	985.25
Removing strainer plates over risers		645	163.12
Cleaning out holes in strainer plates	.....	1,631	458.37
Flushing out filtered water channels	.....	571	144.62
Replacing strainer plates	.....	1,778	450.12
Replacing gravel		3,910	990.25
Transferring sand with ejector	.....	1,218	308.25
Pump and sand ejector operated	......	304.3	48.72
Screening new gravel	.....	2,885	724.87
Unloading new gravel from cars	.....	192	48.75
Loading and unloading gravel from team	.....	1,416	355.87
Hauling with team		307	153.50
Labor of machinist on header caps	.....	69	34.50
Labor of machinist's helper	.....	82	21.50
Common labor on header caps	.....	665	169.37
Foreman's time (65 per cent)	.....	.	650.00
Bags used up in hauling gravel	2,000	...	100.00
Reconstruction of Filters Nos. 2 and 19	.....	...	819.38
Gravel purchased (tons)	1,159	.	1,879.57
Total cost of reconstructing 28 filters			$9,502.76

Common labor cost $2 per 8-hour day until Feb. 1, 1916, after which it was $2.25 per day. The machinist was paid 50 ct. per hour and the machinist's helper $2.25 per day. The team cost 50 ct. per hour. The water used was valued at $7 per 1,000,000 gal. The cost of power was placed at $0.086 per hour; or using 180 gal. per minute for sand ejecting, the cost for power and water was 16c per hour.

Tentative Recommended Practice for Laying Sewer Pipe

At the recent annual convention of the American Society for Testing Materials the following recommendations of Committee C—4, of which Mr. Rudolph Hering is chairman, regarding practice in laying sewer pipe were accepted for publication as a tentative standards of the society.

Preparing Trenches and Foundations for Pipe Laying.

The foundations in the trench should be formed to prevent any subsequent settlement and thereby possibly an excessive pressure and consequent rupture of the pipes.

If the foundation is rock an equalizing bed of concrete or sand well compacted should be placed upon the rock. The thickness of these beds should be not less than 4 in. Pipes should be laid in these beds so that at least the lower third of each pipe is supported its entire length.

If the foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of each pipe and, if necessary to secure a proper bearing for the pipe, a layer of concrete, fine gravel or other suitable material should be placed. The same means of securing a firm foundation should be adopted in case the excavation has been made deeper than necessary.

If there is no good natural foundation, the pipes should be laid in a concrete cradle supported on a masonry foundation carried to a soil of satisfactory bearing power or supported on a structure designed to carry the weight of pipe and its load to a firm bearing.

Trenches should be kept free from water until the material in the joints and masonry has sufficiently hardened.

To protect pipe lines from unusual stresses all work should preferably be done in open trenches.

Pipe lines should be placed at a sufficient depth below the surface of the street to avoid dangerous pressure or impact. When this is not possible special reinforcement should be provided.

Trenches should be only of sufficient width to provide a free working space on each side of the pipe, according to the size of the pipe and the character of the ground, but in every case there should be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly ram the backfilling around the pipe and to secure tight joints.

Pipe Laying.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot ends point in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert.

It is necessary to use all possible care when shoving the pipes together, so that the joints will not be unnecessarily large.

Bells should be carefully cleaned before pipes are lowered into trenches. The pipes should be so lowered as to avoid unnecessary handling in the trench.

The pipes should be set firmly accordingly to line and grade, and the joints carefully adjusted and filled with the jointing material.

Joints should be made in the following manner. A closely twisted hemp or oakum gasket of suitable diameter, in no case less than ¾ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular spaces between the pipes with a suitable calking tool. When cement joints are used, the gasket should first be saturated with neat cement grout. The remainder of the space should then be completely filled with the jointing materials.

Backfilling Trenches.

All trenches and excavations should be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be solidly tamped about the pipes up to a level at least 2 ft. above the top of the pipes. This material should be carefully deposited in uniform layers. Unless otherwise permitted, each layer should be carefully and solidly tamped or rammed with proper tools so as not to injure or disturb the pipe line.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravelly materials. If this method is used, the first flooding should be applied after the backfilling has been compacted by tamping up to 2 ft. above the top of the pipes, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipes and also to prevent an undue excess of pressure upon them.

Walking or working on the completed sewer, except as may be necessary in tamping or backfilling, should not be permitted until the trench has been backfilled to a height of at least 2 ft. over the top of the pipes.

The filling of the trench should be carried on simultaneously on both sides of the pipes in such a manner that injurious side pressures do not occur.

A Page from Recent Water Works Reports

Water Rates for Lawn Sprinkling.—At Toledo, O., the water used for lawn sprinkling from outside hydrants, in connection with the dwellings securing water on flat rates, is charged as follows:

Lawns under 1,000 sq. ft.	$1.50 per season
Lawns from 1,000 to 2,000 sq. ft.	3.00 per season
Lawns from 2,000 to 3,000 sq. ft.	4.50 per season

Lawns over 3,000 sq. ft. are not furnished water on flat rates, meters being required for this service.

Cost of Filtering Water at Providence, R. I.—The unit costs of filtering and pumping water at the Pettaconsett slow sand filters of Providence, R. I., have been as follows:

Year.	Pumping on to filter beds.	For cleaning beds.	Total cost per mil. gals. to filter water.	Pumping water to Sockanosset reservoir.	Remarks.
1907	$3.28	$4.20	$7.48	$5.63	Open beds
1908	3.48	2.03	5.51	5.03	Covered beds
1909	3.22	2.05	5.28	5.11	Covered beds
1910	3.20	1.78	4.98	4.74	Covered beds
1911	2.98	1.59	4.57	4.95	Covered beds
1912	2.72	1.56	4.28	5.05	Covered beds
1913	3.00	1.59	4.59	4.98	Covered beds
1914	3.15	1.71	4.86	4.78	Covered beds
1915	3.07	1.66	4.73	5.67	Covered beds
1916	2.79	2.13	4.92	5.40	Covered beds

24-Hour Laboratory Control of Filtration Plant.—Laboratory control of the water purification works of Toledo, O., was increased in 1916 to the extent that supervision is now maintained during the full 24 hours of the day. To accomplish this two additional chemists were employed. Previous to last year the single 8-hour method was in use. Under the new plan a more uniform operation of the plant has been obtained. Samples for chemical analyses are taken every 2 hours; samples for bacterial examination are taken every 8 hours. Composite chemical samples are then prepared for daily, weekly and monthly tests.

Operating Results of Filtration Plant of Providence, R. I.—Some operating results of the slow sand filters of Providence, R. I., for 1916 were as follows:

No. of filter.	Times scraped.	Total hours in service.	Total quantity of water filtered during the year in gallons.	Average quantity of water filtered between scrapings.	Average quantity of water filtered per day.
1	18	8,216.0	687,650,000	38,200,000	2,010,000
2	15	8,187.5	706,180,000	47,080,000	2,070,000
3	19	8,131.5	686,110,000	36,110,000	2,030,000
4	17	8,131.0	634,510,000	40,850,000	2,050,000
5	19	7,969.5	681,990,000	35,890,000	2,050,000
6	18	8,144.0	690,310,000	38,350,000	2,040,000
7	16	8,176.0	693,470,000	43,340,000	2,040,000
8	17	8,098.0	704,690,000	41,450,000	2,080,000
9	17	7,969.5	678,060,000	38,890,000	2,040,000
10	17	7,996.5	680,790,000	40,050,000	2,040,000
Total	..	....	6,903,760,000	....	....
Av. of plant	17.3	8,101.9	....	40,020,000	2,045,000

Lengths of run in days: Maximum, 59.3; minimum, 2.3; average, 19.5.

Cost of Filtering Water at Cincinnati, O.—The total cost of operating and maintaining the filtration plant of Cincinnati, O., during 1916 was $66,370, of which $59,084 was for the operation and $7,286 for maintenance. Coagulating chemicals cost $24,375, of which $5,019 were for lime and $19,356 for sulphate of iron. The total cost for disinfection was $1,667. The cost per 1,000,000 gal. of filtered water delivered for consumption was $3.45, of which $3.07 was for operation expenses and 38 ct. for maintenance charges. Operation expenses included $1.27 per 1,000,000 gal. for coagulating chemicals, 20 ct. for chlorine for disinfecting purposes and $1.60 for all other purposes, but consisting chiefly of labor. It will be seen from a study of the following table showing the costs per 1,000,000 gal. of filtered water delivered for consumption for each year since the plant was started, that only in 1914 was the plant operated at a lower cost than in 1916.

COST PER MILLION GALLONS OF FILTERED WATER DELIVERED FOR CONSUMPTION

Year.	Operation		Maintenance.	Total.
	Coagulating chemicals.	All other operating costs.		
1908	$1.72	$2.47	$0.05	$4.24
1909	1.89	2.28	.09	4.26
1910	1.93	1.98	.28	4.19
1911	1.86	1.91	.35	4.12
1912	1.78	1.68	.38	3.84
1913	1.67	1.77	.48	3.92
1914	1.21	1.78	.39	3.38
1915	1.43	1.86	.76	4.05
1916	1.27	1.80	.38	3.45
Average (9 yrs.)	$1.64	$1.95	$0.35	$3.94

Operating Results of Filters at Cincinnati, O.—The following table shows the total number of filtering hours for each month of 1916, the average period of service of the filters, the number and length of washings, and the average percentage of filtered water used for washing:

FILTRATION.

Month, 1916.	Total number of filtering hours.	Av. period of service (hours).	Total number of filter washings.	Av. length of time required to wash a filter (minutes).	Per cent of total water filtered used for washing filters.
January	9,217.41	22.43	416	4.50	1.53
February	8,551.60	22.92	373	4.50	1.51
March	9,137.59	20.11	454	4.50	1.74
April	8,605.52	25.94	333	4.50	1.33
May	9,475.88	34.47	264	4.50	.95
June	9,197.32	36.95	248	4.51	.94
July	11,313.69	20.26	563	4.50	1.74
August	11,617.34	13.00	942	4.24	2.72
September	10,509.72	12.76	824	4.47	2.61
October	9,583.06	19.03	499	4.50	1.63
November	8,836.24	20.70	441	4.47	1.53
December	9,125.40	19.90	459	4.50	1.54
Totals	115,170.83	.....	5,816	...	....
Averages	....	22.37	.....	4.47	1.65

Cost of Water Works Materials at Cincinnati, O.—The following figures from the report of the Water Works Department of Cincinnati, O., for the year ending Dec. 31, 1916, shows the increase in the cost of material and supplies in 1916 over the prices paid in 1915:

Coal, river delivery	Ton	$1.80	to	$4.07	128%
Coal, rail delivery	Ton	2.25	to	4.23	88%
Bulk lime	Ton	5.50	to	6.50	18%
Sulphate of lime	Ton	11.50	to	16.25	31%
Liquid chlorine	Pound	.08	to	.16	100%
River sand	C. Y.	1.25	to	1.75	40%
Fire brick	M.	36.00	to	59.00	64%
Cement	Bbl.	1.92	to	2.56	33%
Fire clay	Bbl.	1.50	to	1.65	3%
Silica sand	Bbl.	1.00	to	1.35	35%
Baffle tile	Each	.06	to	.08	33%
Boiler tubes	L. F.	.20	to	.46	130%
Grate bars	Pound	.015	to	.035	133%
Waste	Pound	.0825	to	.14	70%
Rags	Pound	.06	to	.08	33%
Flax packing	Pound	.60	to	.70	17%
Asbestos packing	Pound	.15	to	.85	465%
Oils, turbine	Gal.	.145	to	.165	17%
Oils, cylinder	Gal.	.27	to	30	10%
Gasoline	Gal.	.14	to	.18	29%
Graphite	Pound	25	to	.33	33%
Emery cloth	Sheet	.02	to	.05	150%
Linosoap	Pound	.044	to	.085	98%
Natural gas	M. C. F.	.122	to	.157	29%
Pig lead	Pound	.04	to	.10	150%
Cast iron pipe	Ton	27.50	to	41.00	49%
Special castings	Ton	70.00	to	90.00	29%
Brass castings	Pound	20	to	.35	75%

Cost of Meter Maintenance at Chicago.—The average cost of water meter maintenance by the city of Chicago for the past 8 years has been as follows:

Year.	Per meter.	Year.	Per meter.
1909	$6.03	1913	$3.97
1910	5.26	1914	3.57
1911	4.73	1915	3.44
1912	4.45	1916	4.40

Reasonable Limits of Accuracy for Valuation of Water Utility Properties

By ALLEN F. BREWER,
Assistant Engineer, Valuation Department, Public Utility Commission of New Jersey.

Much has been written during the past few years with regard to public utilities, their management, regulation and valuation; all with the purpose of aiding to more efficient fixing of rates and placing the securities of such types of corporations on a fair and equable investment basis. In order to arrive at the results in view, whether it be regarding reasonable rates, the issue of new securities, or the legality of any proposed form of reorganization, the primary step is to fix a fair and impartial value, either reproduction new or present, or both, of the property in question. Today, in nearly all states where state control and supervision of public utilities is exercised inventory and appraisal are necessary by law where questions arise which would affect the interests of the investing or consuming public. It is with the accuracy required in such inventories and appraisals of water companies that this article has to deal. Before discussion of the subject, however, it might be well to state one of the most recent definitions applied to inventory and appraisal: Dr. Philander Betts, public utility expert and Chief Engineer of the Board of Public Utility Commissioners, state of New Jersey, in his paper presented at the San Francisco Convention of the American Institute of Electrical Engineers, Sept. 16, 1915, says: "Inventory is the listing of all items of material and labor which the particular company was required to produce or provide or obtain in the construction of its plant at the time and in the manner under which it was constructed." He defines appraisal as: "The affixing of such prices to the items found in the inventory as will fairly represent the normal cost considered over a period of years."

The above definitions will be of interest to the valuation engineer in preparing for any particular work at hand. It must be noted, however, that to follow Dr. Betts' opinion to the letter would entail an intensive study to obtain the data required. In certain cases of water utility valuation such is not essential. Yet, the limits to which observations should be carried are often a point of doubt to the engineer. It is only possible to clarify this doubt by obtaining a full and unbiased conception of the exact purpose for which each particular appraisal with which he is concerned is to be made. This should be done before any field work whatever has been attempted. Very often an appraisal may be justifiably covered by a cursory examination of the physical property, particularly if the bonded indebtedness is low and the plant has been maintained in an efficient manner. Other cases may require the most intensive study of the construction and managing methods of the utility in question.

It is with purchase and rate cases, of course, that the greatest care is demanded in every detail of valuation work. Estimation is accepted only after all due research has proven unavailable; here the point directly in mind is with respect to unit cost data. Therefore, the valuation engineer must plan his study to cover the complete records of any company he is to deal with. This should be carried out in order of accounts and the data should be worked up in order that the final unit costs derived may be directly applicable to the field inventory. For example, consider the distribution system of a water company. To assume the results derived from a study based on the preceding 15 years of operation is entirely fair to use in deriving cost data. For this period all work orders or vouchers should be analyzed, and unit costs of cast and wrought iron pipe, lead, yarn, and weights of pipe by sizes, and any details as to labor costs, cartage, freight, excavation, etc., should be suitably tabulated. If this has been properly done and weighted averages obtained, it will then be possible to derive: (1) the cost of installing pipe with earth excavation, no pavement and easy digging; (2) the additional cost of installing pipe with excavation through rock of any estimated percentage of the total excavation; (3) the additional cost of installing pipe where various types of pavement are encountered; (4) the additional cost of installing pipe where railroad or stream crossings are encountered. The field inventory should be attacked in a proportionally careful manner, by listing all mains by size and township, scaling same from maps or listing from any available record at hand, such as the extension ledger, or detailed authorizations and reports thereon.

Other items which go to make up the tangible property accounts should be studied likewise. Costs of buildings, mechanical equipment, pumps, hydrants, dams, etc., must always be noted from the records, if such are properly kept. As well, dates of erection or installation should be noted, as these would of course govern the proper depreciation charges. Likewise, the dates of beginning each installation and when same went into service are pertinent in deriving a fair percentage for "Interest during Construction." It is well for the engineer to ever bear in mind that there should be no reason for doubt in any of his results if it can be possibly avoided. Rate investigations receive quite as much attention from a legal point of view as they should from an engineering, and on the engineering observations or results will be based all legal arguments for or against the action proposed. Hence, the valuation engineer, to conserve his reputation, must take every means to be able to back up his opinions by facts. If he has had to resort to estimation where adequate data was unavailable he should make intensive comparisons with data used in previous cases of a similar nature, taking care to allow for difference in labor, raw material costs, or other pertinent facts at the periods in question. Such a procedure will frequently result in figures of considerable value, in themselves, as cost studies.

Where valuation is to be made of a water utility property to furnish a basis for security issues, reorganization or merger, in most cases such an intensive study of cost data is not so necessary. Of course unit costs must be derived, but they may often be fair estimates based on the engineer's experience, or derived as explained above. For this reason it is most essential that the valuation engineer keep a detailed file of all cost data he is able to obtain for use in future appraisals. With the aid of such a file, and a fair knowledge of the financial conditions of the company with which he is dealing, he may frequently make a tentative valuation without field inspection, based on the company's annual inventory at any particular date. Where minor bond issues are in question such an appraisal will generally be adequate for a State Public Utility Commission to base its opinion upon. Should there be any doubt, however, as to the full extent of the value of the fixed assets the engineer ought in every case to make it a point to confirm his data, even to a detailed field inspection and inventory.

It may often be noted by detailed study of certain valuation reports, that the precision to which cost data has been calculated is out of all proportion to the results desired or the purposes for which the report was made. For instance, many of the younger members of the engineering profession who have to deal with valuation cost data will perform intensive studies of cost of water mains, taking days and even weeks to derive their data. Then in another account will they estimate water diversion rights or charges for engineering, superintendence and contingencies offhand at a lump figure. To be true, such items have of necessity to be estimated, but is it not entirely evident that where such large estimations must follow, it is not rather uncalled for to figure costs of pipe, lead, yarn, etc., to tenths of a cent or even more accurately? The relative precision of measurements might well be studied by such engineers to the benefit of their future valuation work. It must not be assumed, however, that such will hold true in all cases, nor should the reader infer that the author is too broad in his statements as to the accuracy demanded in appraisal work. No valuation can be carried out at a reasonable cost to all parties concerned without a certain amount of estimation. The point is to base such necessary estimates on data at hand for cases as nearly like the one to be considered as possible.

Special Water Tank Serves as Advertisement

The special steel tank and tower, shown in the accompanying illustration, was constructed recently by the Chicago Bridge & Iron Works for the General Roofing Co., at Richmond, Cal. The tank has a capacity of 50,000 gal. and is elevated 51 ft. above foundations. The diameter and height of the tank above its balcony are designed to correspond with the dimensions of a roll of "Certain-teed Roofing," which is the product manufactured at this plant. A hemispherical bottom was built into the tank to give it added strength and do away with any beams under it which always prove difficult to paint and are very unsightly. The tank is provided with a steel roof, which is almost flat, in order to further carry out the idea of a roll of building paper.

"Roll of Roofing" Tank at Richmond, Cal.

An examination of the photograph will show that the painting details are very well done, and the proximity of this tank to the railroad shown in the background greatly contributes to the advertising value of the structure.

The average net cost of water meter maintenance by the city of Chicago for 1916 was $4.40 per meter. The average cost of new meters installed during the year was $26.90, made up of the following items: Meter, $20.75; material for installing, $2.01; labor to install, $4.14.

Methods and Cost of Constructing a 48-in. Submerged River Crossing at Minneapolis, Minn.

Early this year the city of Minneapolis, Minn., completed the construction of a 48-in. riveted steel pipe ½ in. thick across the Mississippi River just below the Falls of St. Anthony. The work involved many constructional difficulties which were interestingly described by Mr. F. W. Cappelen, City Engineer, in a paper presented at the Richmond Convention of the American Water Works Association, from which the matter in this article is taken.

The river at the point of crossing passes through a gorge some 900 ft. between bluffs, which, on the east side, reach a height of about 100 ft. above low water, and on the west side, 72 ft. On the east side there are 39 ft. of sand and gravel to the Trenton lime rock; on the west side, about 11 ft. from the top of the ground to the lime rock, which is of the same elevation on both sides of the river. This rock is 25 ft. thick and separated from the underlying St. Peter sandstone by 3 ft. of shale. The St. Peter sand rock is some 800 ft. thick. The river has cut through the rock, and the river bottom is filled with broken debris of lime rock and boulders; at the deepest point about 40 ft., then the sand rock.

Eight-foot shafts were sunk on both sides of the river, and 8x7-ft. tunnels extended from the shaft to the edges of the bluffs, 340 ft. long on the east side and 60 ft. long on the west side, and trenches were dug on the shores as far as possible. This work was started Jan. 3, 1916, and completed May 27, 1916.

It was decided to build cribs 4 ft. wide and 8 ft. long, made of 10x12-in. timbers, with partly planked bottoms, each to be loaded with about 2 tons of rock. These cribs were to be placed about 14 ft. apart on centers across the river, and 16 ft. on centers up and down the stream. On these cribs across the river, 24-in. I-beams 28 ft. long were placed flatways to form a running track for the excavator, which consisted of a stiff leg derrick to handle a ½-yd. orange peel bucket. Before building the cribs some excavation was done with this rig on the low shore on the west side, and it seemed as if the material could be handled that way. Accordingly the placing of the cribs across the river was finished and the runway completed from shore to shore. The under frame of the derrick was fitted with grooved wheels which traveled on 40-lb. rails laid loose on the I-beams.

The derrick was then sent back to the west end, and excavating operations continued with the orange peel bucket, but as soon as the river was reached it was found that the bucket would not work satisfactorily at all, and the rig for excavating was changed by attaching to the boom of the derrick a dipper stick, placed about 20 ft. from the end of the boom, with a ¾-yd. steam shovel dipper. The excavation with this machine commenced Feb. 18, 1916, and the ditch was finished March 17, 1916. It was a very hard job. The material was exceedingly bad to handle; big pieces of ledge from earlier erosions were often encountered and they had to be dragged out. Some 2,500 yd. of this stuff was excavated and dumped on the downstream side. All small material was immediately washed away by the current, leaving the heavier stuff in place. As the excavation progressed towards the east side the cribs were removed. I-beams were placed on the spoil bank as a track to carry the cribs, timbers and I-beams back to the west shore. These beams also formed the pathway between the excavator and the west side.

On March 21, 1916, riveting the 48-in. pipe was commenced. The sections were all 30 ft. long, and on March 26, 1916, pulling the pipe towards the east shore was commenced. The first section pulled was 120 ft. long. To the end was riveted a torpedo-shaped head 6 ft. 7 in. long, with heavy lugs, to which a ⅞-in. plow-steel iron-center pulling cable was attached. The pulling was done with a 25-h.p. hoisting engine and two triple sets of blocks. After this first section was pulled, 30-ft. sections were added and pulled, and on March 30, 486 ft. of pipe had been pulled and another day would have landed the end on the east shore. This very day the ice broke in the upper river, about two weeks ahead of ordinary conditions; and a big ice gorge, which had formed about 15 miles above the falls. broke and a tremendous flood of water came down, in fact, about 54,000 cu. ft. per second. The flood simply picked up the pipe and laid it downstream on the flat west shore, only shearing part of the rivets in one joint about midways. The inside cable, which was always anchored on the west shore, saved the pipe. A few days afterwards, 10,000,000 ft. of logs broke away at Anoka, 18 miles from Minneapolis, and came down over the falls and cleaned out the spoil bank, I-beams and all. The beams were picked up later.

Nothing could be done now until the river went down again. In July, the pipe was taken from where the flood had left it. It was straightened, joints repaired and tested, and placed in position for handling again under low-water conditions. Meanwhile, the work of building shafts and tunnels went on, and was completed with the lining on May 27, 1916. The shafts were lined with concrete, and the tunnels with 6-in. vitrified tiling.

The ditch was completely filled, of course, after the flood, with sand, gravel, and smaller boulders, and it was decided that the surest and best way to excavate again would be with a drag-line excavating outfit as follows: The track cable was started from a 14x14-in. mast, 48 ft. high set up on the east shore. The elevation of the cable hitch was about 116 ft., the west end of cable being fastened to a bridle cable subject to pull up or down stream, with a set of ¾-in. double blocks at an elevation of about 31 ft. The total span was about 980 ft. The track cable was 1½-in. plow steel, the load line was ⅝-in. plow steel, and the tension line was ¾-in. plow steel. The hoisting engine was rated at 25 h.p. with steam pressure of 125 lb. A ½-yd. bucket was used. A 20-h.p. engine was placed on the west side. Setting up the cable and engine began Sept. 11, 1916, and drag line excavation on the river proper began Oct. 16, 1916, and was finished Jan. 20, 1917.

The material was about as expected, but in the bottom of the trench large pieces of ledge were encountered that probably had been shifted into place during the early stages of the flood, and it became necessary to break these large masses of dynamite before the drag could handle them.

The drag line bucket was dumped on staging placed directly over the east side trench, and the material slid down on the spoil bank made on the shore just below the pipe line.

On Jan. 22, 1917, pulling the river sections of the pipe was begun, as before, and the pulling was finished on Jan. 31. The last pull was about 15 ft. of a total length of pipe of 698 ft. As the pipe was pulled and sections added, water was let into the pipe on the west end, so as to keep it just about afloat above the bottom of the trench. The pipe was gradually lowered into place from the west end, and closed in and riveted by Feb. 9, 1917. On the east end, a cofferdam had to be built over the pipe, so as to make it possible to cut off the torpedo-head, put in the remaining pipe and make connections with the end of pipe at the mouth of the east tunnel. Much trouble was experienced in unwatering the coffer, as sand rock was encountered inside the dam and no puddle clay could be had with the extreme cold weather, 20° below zero all the time. However, the east end work was closed in on March 10, 1917.

As soon as the pipe had been properly placed, on Feb. 12, the work of anchoring it started. This was done by placing very coarse fabric bags filled with sand and cement mixed 1:4, around the pipe, filling the entire trench in spots. Ten such anchors were placed, containing 18,000 sacks. The sand and cement were delivered on top of the west bluff. The sand was heated and mixed dry with the cement in a small mixer and the sacks filled, slid down a plank chute, wheeled to the river edge, then loaded on the drag line bucket which was fitted with a small platform large enough to hold 12 bags. The east side engine pulled the bucket out over the pipe in the river and the west side engine pulled it back. As soon as the sacks had been thrown into place, holes were punched in them by sharp pointed rods to facilitate the wetting of the contents. The cement set satisfactorily. This work was finished March 3, 1917.

On March 21, 1917, the entire work on the east side was finished, with the cofferdam removed. With everything ready, the expected flood came on April 4. The ice gorge broke about 14 miles above the falls and came very violently, but without doing any harm to the main. The work was done entirely by the city's forces, under the charge of Mr. J. A. Jensen, Supervisor. The pipe was furnished by the East Jersey Pipe Co.

The total length of the crossing was 1,526 ft., while the channel portion was 868 ft., tunnel and shaft portion 678 ft. The detailed cost of the work was as follows:

Material	Amount	Cost per foot of crossing
1,526 ft. of 48-in. by ½-in., 48-in. by 7/16-in. and 48-in. by ⅜-in. riveted steel pipe	$16,591.85	$10.87
48-in. gate and air valves	1,537.69	1.01
Lead, cast iron pipe and specials	287.27	.19
Fittings and incidental supplies	204.55	.13
Bolts, pins, steel and iron	1,001.47	.65
Timber, blocking and lumber	2,041.64	1.33
Cement for bag anchorage and shore wall	800.16	.52
Sand for above, and for filling trench and cofferdam	647.31	.42
Burlap bags for anchorage	1,021.31	.67
Paint and coating material	66.36	.04
Cable	371.00	.24
Electric power for lights and pumping	48.77	.03
Coal for engines and shanty use	1,184.94	.77
Oil, gasoline, candles and waste	742.26	.48
Dynamite and leads	382.11	.25
Tools, rope, derrick repairs, etc	1,001.39	.65
Transport machinery	194.55	.12
Repairs and parts	387.23	.25
Miscellaneous material	139.83	.09
Total	$28,652.69	$18.77

Labor.	Amount.	Cost per foot of crossing
Handling and dumping dredge material	$2,215.79	$1.45
Timbering and sheating, etc	1,358.84	.89
Hauling pipe and specials	728.79	.48
Hauling supplies and equipment	3,210.90	2.10
Rigging up engines, cableways, etc	4,062.04	2.66
Foreman and supervision	2,888.45	1.89
Building cribs, etc	1,598.21	1.05
Transporting and setting cribs	315.95	.21
Dredging with shovel	2,416.09	1.58
Dredging with drag line	4,801.61	3.15
Watchmen on engines and camp	1,473.20	.97
Boiler work on steel pipe	4,193.53	2.75
Blacksmith, tool work and repairs	1,203.61	.79
Cutting pipe	287.88	.19
Scraping, cleaning and recleaning and painting pipe	481.31	.32

Setting 48-in. gate and expansion joints	121.50	..
Settting air valves	7.50	...
Laying and erecting pipe in tunnel and shaft	898.68	.59
Anchoring pipe with filled bags	1,490.86	.98
Unwatering cofferdam	497.70	.33
Concreting east shore	298.05	.20
Pulling pipe into channel	691.43	.43
Moving materials	223.56	.15
Miscellaneous work	688.83	.45
Total	$36,154.31	$23.69
Total cost of labor and material*	$64,807.00	$42.46

*Unit cost per foot in channel. Cement for bag anchorage and shore wall, $0.94; sand for same and for filling trench and cofferdam, $0.77; burlap bags for anchorage, $1.19; dynamite and leads, $0.45; rigging up engines, cableways, etc., $4.79; building cribs, etc., $1.88; transporting and setting cribs, $0.37; dredging with shovel, $2.84; dredging with drag line, $5.67; anchoring pipe, $2.20; unwatering cofferdam, $0.59; pulling pipe into channel, $0.82.

The cost of the pipe in the tunnel and shaft was $1.32 per foot.

Detail Cost of Shafts, 149.7 Feet in Total Vertical Length.

	Amount.	Cost per vertical foot.
Material:		
Coal for hoist	$150.00	$1.00
Crushed rock for concrete	237.75	1.58
Dynamite and caps	75.00	.50
Tools, etc.	125.00	.83
Cement for lining shafts	1,000.00	6.67
Use of hoisting machinery	171.45	1.15
Repairs and parts	50.00	.33
Lumber	200.00	1.34
Drilling 6-in. hole through rock for drainage	66.15	.44
Miscellaneous material	40.00	.27
Total	$2,115.35	$14.13
Labor:		
Supervision and foremen	$ 473.91	$3.16
Watchmen on engines	1,012.20	6.76
Excavating	1,370.89	9.16
Bracing	208.75	1.39
Sheathing	91.00	.61
Bailing water	90.00	.61
Drilling	246.50	1.65
Blasting	34.25	.23
Building trestle	3.00	.02
Cribbing under shaft	5.00	.03
Concreting	286.69	1.92
Rigging up mixer	105.00	.70
Moving derrick	15.00	.10
Placing beams in shaft	76.10	.51
Back filling	102.50	.68
Hauling materials	401.36	2.68
Total	$4,522.15	$30.21
Total cost labor and material	$6,637.50	$44.33

Detail Cost of Tunnels, 392 Feet in Total Length.

Material:		
Crushing rock	$ 174.24	$0.44
Dynamite and caps	75.00	.19
Wall tile for lining	724.66	1.85
Tools, etc.	125.00	.32
Cement	160.30	.41
Repairs	50.00	.13
Lumber	50.00	.13
Drain tile	42.14	.11
Power and lights	75.00	.19
Miscellaneous material	40.00	.10
Total	$1,516.34	$3.87
Labor:		
Supervision and foremen	$ 473.91	$ 1.21
Excavating	1,260.28	3.22
Drilling	104 00	.27
Blasting	84.75	.22
Bracing	229.13	.58
Laying tracks	142.20	.36
Excavating for drain tile	72.75	.19
Back filling	375.63	.96
Laying drains	69.25	.18
Excavating for lining wall foundation	90.50	.23
Lining tunnel with the walls and arch	604.19	1.54
Concreting wall foundation	344.00	.88
Hauling materials	401.36	1.02
Total	$4,251.95	$10.84
Total cost labor and material	$5,768.29	$14.71

The total cost of water purification at Toledo, O., for 1910 was $127,835, the total cost per 1,000,000 gal. delivered being $16.96. Other figures from the last annual report of the Division of Water follow:

Cost per 1,000,000 gal. delivered, alum and hypochlorite treatment	$ 12.39
Cost per 1,000,000 gal. delivered, iron, lime and hypochlorite treatment	16.89
Cost per 1,000,000 gal. for chemicals, alum treatment	5.57
Cost per 1,000,000 gal. for chemicals, lime and iron treatment	9.47
Average cost of chemicals per ton:	
Alum	28.00
Iron	21.20
Lime	7.82
Hypo	180.00

On Jan. 1, 1917, there were 219 sewage disposal plants in the State of New Jersey, and 8 additional plants were under construction.

Experiences with Leadite Joints at Windsor, Conn.

In connection with the extension of the distribution system of the Windsor Fire District of Windsor, Conn., about 28,000 ft. of 10-in. water mains were laid with leadite joints. In taking bids on this work alternative prices were asked for laying the cast iron pipe with lead joints and with leadite joints. The contractor awarded the work offered to install the pipe with leadite joints for 10 ct. per foot less than with the lead joints. The method of installing the joints and the results of their tests were described by Mr. H. R. Turner, Superintendent and Engineer of the District in a paper presented at the recent convention of the New England Water Works Association, from which this note is taken.

Better results were obtained with the joints if the pouring was kept back at least four lengths of pipe from the laying gang. The shock of driving home a new length of pipe tends to break a freshly made joint.

As the standpipe was not completed when the pipe lines were laid exact tests of joints after pouring were omitted, but each joint was inspected when a section was filled with water before backfilling was done. Final tests were made in 1917.

The only method available in making these tests was to shut off each service connection at the curb cock and to shut off all gates on adjacent lines. Table I gives data showing the number of services and length of service connection involved in the tests, and also the number of gates which it was necessary to close. No doubt some of the water measured as leakage was lost through leaky services or gates, but the results in Table III have been figured on the assumption that the total loss of water was through the leadite joints only. The standpipe was pumped full of water to give the maximum available pressure on the lines to be tested. Table II shows the relative pressures on different sections of the line, 35 per cent of the length ranging from 45 to 70 lb. and 65 per cent ranging from 70 to 98 lb. per square inch. The standpipe was shut off from the distribution system and the water supplied for leakage on the tested lines was by-passed through a 1-in. meter. Gage readings of the pressure on the lines were taken at two points during the tests. The duration of the test was 4 hours; the actual quantity of water registered through the meter was 39.4 cu. ft. or 1773 gal. per 24 hours. Correction for under registration of the meter gave a total loss of water from leakage of 1,861 gal. of water per 24 hours or 0.360 gal. per 24 hours per lineal foot of joint.

TABLE 1.

Location.	Length of main. 10-in. Ft.	8-in. Ft.	Total No. joints. 10-in.	8-in.	6-in.	Services. No.	Length. Ft.	Gates. No.	Size.
Sage Park Road	7,674	128	656	16	7	4	70	3	8
Windsor Ave.	14,640	...	1,271	..	48	58	1,633	2 4	10 6
Total	22,314	128	1,927	16	55	62	1,703		

TABLE 2.—RANGE OF PRESSURE ON MAINS.

Location.	Length, ft.	Pressure. lbs. per sq. in.	Per cent of length.
Sage Park Road	2,228	45	10
Sage Park Road	5,574	64	25
Windsor Avenue	7,600	73	34
Windsor Avenue	4,400	94	19
Windsor Avenue	2,640	98	12
Total	22,442		

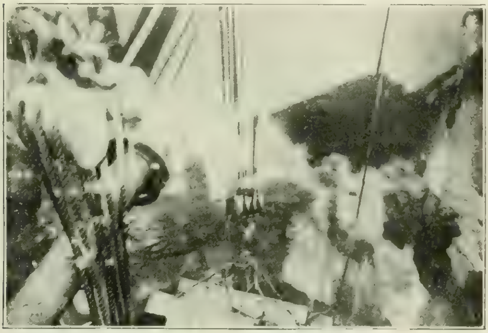
TABLE 3.—LEAKAGE—SAGE PARK ROAD AND WINDSOR AVENUE.

Date.	Size main. In.	Lin. ft. joint.	Leakage in gal. per 24 hrs. Total.	Per lin. ft. joint.
Aug 24, 1917	10	10″—5,048	.....	.....
		8″— 33	1,861	0.360
		6″— 86	.....	.....

Cement Gun Seals Well Against Seepage of Ground Water

Seepage of ground water into an old well at the plant of the American Bridge Co. on 40th and Stewart Aves., Chicago, has been eliminated by a combination of cement gun work and hand work. The well is about 25 ft. in diameter and 30 ft. deep, and is used as a sump or cistern in which the waters from the various parts of the plant accumulated and from which it was pumped to the boilers. The old lining of the well probably was rubblestone which later had been concreted. Ground water seeped through the walls in such volume as to seriously damage the water for boiler purposes.

The following method was employed in making the well tight against the seepage of water from the outside: A wire mesh was first attached by spikes to the inner walls of well, covering all the side walls from top to bottom. A cement coating was then shot into place through the wire mesh by the cement gun. Around the upper edge no serious difficulty was encountered, but farther down where the pressure of the ground water was greater much trouble was encountered in making the cement stick. The seepage was so general that it washed off the gun-crete coating as fast as it was put on. To overcome this difficulty the work was carried out as follows:



View Looking Down Into Well.

A thin coating was first shot into place with the cement gun. Part of this washed off and part of it remained. This was allowed to set. Then another thin coating was applied, making additional areas dry. The work proceeded in this way until the leaks were localized. Holes were then drilled and fitted with pipes for weep-holes, thoroughly localizing the water. When nothing further could be gained in this way, the weep-holes were drilled out larger and plugged by pounding in waste and old rags, so as to temporarily hold back the water. Patches made of a mixture of cement and soda were then put on by hand with rubber gloves and held in place until they had set. Inch by inch the surface was covered and the whole area was then given a final cement coating. When the work was finished the walls of the well were dry and there was no seepage from the outside.

The entire work, except for the upper 5 or 10 ft., was done by 1 man and a helper, with the additional assistance of 4 men occasionally. The work was done by contract by the Dewey Cement Gun Construction Co. of Chicago.

Comparative Cost of Operating Automobiles and Teams on Irrigation Project

Some interesting comparative costs of the use of automobiles and teams on an irrigation project of the U. S. Reclamation Service are given by Mr. Charles P. Williams, Project Manager, in the October Reclamation Record, from which the matter following is taken.

The Sun River Project had in use during 1916 four 5-passenger touring cars—one (No. 1) a 1913 model, purchased in March, 1913, one (No. 2) a 1914 model, purchased in April, 1914, and two 1915 models No. 3, purchased in August, 1915, and No. 4 transferred from the Fort Peck project in December, 1915.

No. 1 car had on Dec. 31, 1916, been run 28,975 miles, and although parts of it have been renewed lately and are in good condition the car as a whole is not economical to operate on account of the cost o fand delays for repairs. It was used the entire season as an expeditious means of transporting men and light freight between the work by Government forces on the upper Pishkun Canal and Gilman, the nearest railway station, a distance of about 20 miles, and in the maintenance of telephone and transmission lines on the western end of the project. The car traveled during the year 7,726 miles; the total and unit costs for this distance are shown below:

Item.	Total cost for 7,726 miles.	Unit cost.
Gasoline	$149.17	$0.0193
Lubricants	19.14	.0025
Tire repairs	121.93	.0158
Other repairs	315.39	.0408
Supplies	11.26	.0014
Plant	214.01	.0277
Project general expense	38.31	.0049
Total	$869.21	$0.1128

No accurate direct comparison of actual costs of the operation of this automobile and that of teams can be made, but it is estimated that the automobile did the work that would have required the constant use of two good driving teams, used alternately so as to give each team rest between long hard drives. The average cost of feeding a team on this project is about $1.40 per day. If we assume that a plant charge of 60 ct.—the average for this project for the 1916 season—on each team and wagon will be charged for each day used, and that 30 miles per day will be an average day's trip for the teams, the estimated cost of teams for this use is as follows:

Item.	Total cost for 7,726 miles.	Unit cost.
Feed for teams (730 team-days, at $1.40)	$1,022.00	$0.1323
Depreciation or plant charge (258 days, at 60 cts.)	154.80	.020
Total	$1,176.80	$0.1523

There was therefore a saving of $307.59 by the use of the automobile, which does not include the time saved on account of the greater speed and range of the automobile.

No. 2 car was used exclusively by the superintendend of irrigation in the operation and maintenance of the Fort Shaw unit, and had on Dec. 31, 1916, been run 21,936 miles. This car traveled during the year 5,280 miles; the total and unit cost for this distance are shown below:

Item.	Total cost for 5,280 miles.	Unit cost.
Gasoline	$118.88	$0.0225
Lubricant	13.28	.0025
Tire repairs	58.41	.0111
Other repairs	170.24	.0322
Supplies	36.92	.0070
Plant	158.27	.0300
Project general expense	17.13	.0032
Total	$573.13	$0.1085

Prior to the season of 1915 this travel had been accomplished wholly or in large part by driving team and buggy. The distance traveled was about the same, but more time was required for it. Assuming the same conditions as for car No. 1, except that only one team would be used and the average day's trip reduced to 20 miles, the estimated cost of the use of a team for this work is as follows:

Item.	Total cost for 5,280 miles.	Unit cost.
Feed for team (365 days, at $1.40)	$511.00	$0.0967
Depreciation or plant charge (264 days, at 60 cts.)	158.40	.030
Total	$669.40	$0.1267

The estimated saving in operating cost through the use of the automobile is therefore $96.27. The low team cost is probably at the expense of the team, as it was found that by using only one team it was difficult to keep the team in good condition and the estimated depreciation is therefore probably low.

There is also a saving made in the time of the superintendent. Although he is employed by the year, and for this particular piece of work, nevertheless if the time he spends in driving around the work can be shortened and the time thus gained spent on work that he would otherwise have to delegate to some one of his subordinates, there is a definite money amount saved to the project. If we assume an average speed of 7 miles per hour for team travel and 15 miles per hour for the automobile travel, the time saved in the yearly travel of 5,280 miles would be 402 hours, or 40 10-hour (field work) days. At $140 per month this would amount to about $187. The total saving by the use of automobile for this work may therefore be estimated at $283.27.

No. 3 car was used by the project manager on administrative work exclusively, and the mileage for the year was 6,749. The total mileage to Dec. 31, 1916, was 9,242. The entire project from Beaver Creek Dam site to Benton Lake Reservoir was covered and trips varied from 30 to 150 miles per day. The large part of the saving was in the project manager's time. If we assume the same relative speeds of transportation as above, there was a saving in time of 514 hours or 64¼ 8-hour days. At the rate of $10 per day the saving in time alone would be $642.50. Assuming that the project manager may work 9 hours per day there would still be a saving in time of about $570. As the project manager on this project has used an automobile since 1910, and the work of the project has expanded materially since that time, so that it would now be almost impracticable for him to cover the work on the project with a team and do any other work, a direct comparison of operating costs of the two methods of travel can not be practicably made.

No. 4 car was used almost exclusively in the supervision of construction work by the resident and construction engineers. The total mileage to Dec. 31, 1916, was 9,965, and the mileage for the year was 7,089. Daily mileage varied from 30 to 70 and the monthly mileage averaged about 710 during the construction season. To accomplish the same mileage would have required at least two single driving horses, for which the cost would have been about half as much as for the teams mentioned, or, say, $590. The cost of operating No. 4 car for 7,089 miles was as follows:

Item.	Total cost for 7,089 miles.	Unit cost.
Gasoline	$141.12	$0.0200
Lubricants	4.25	.0006
Tire repairs	78.85	.0111
Other repairs	48.66	.0069
Supplies	8.55	.0012
Plant	265.96	.0375
Project general expense	13.57	.0019
Total	$561.26	$0.792

The automobile transportation cost, therefore, $28.74 less than the estimated cost of 1-horse team transportation for the same distance ($590—561.26). Assuming the same relative speeds of transportation as above, there was a saving in time of 540 hours or 54 10-hour (field work) days, which at the rate of $6.67 per day would be a saving of $360. The total saving would therefore be $388.74.

Reducing the Peak Load by a Remotely Controlled Waterworks Pumping Unit

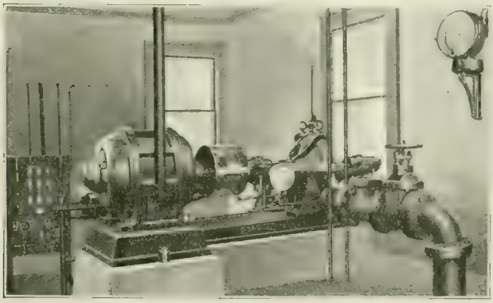
The Water and Light Commission of Fort Atkinson, Wis., had been pumping water for many years with steam. A low rate was made them for electricity transmitted from Milwaukee. To make use of this cheaper power, they put in at the main pumping plant about a year ago an "American" 4-in. single-stage, double suction, bronze-fitted centrifugal pump direct connected to a 40-h.p. General Electric motor, having a daily capacity of 1,000,000 gal. against a total head of 175 ft. when operating at 1,750 r.p.m.

Electrical Connections and Housing for Pumping Station.

The performance of this pumping unit was so satisfactory that the Commission decided to make a further power saving by installing another pump to relieve the peak load and deliver as much water into the mains at as low a rate of flow as possible. This served to keep down the maximum demand charge for current and thus gave a better current rate.

Located about 4,000 ft. from the main pumping station, at which the first installation was made, the city has a flowing well. To pump the water from this well into the mains, a pumping unit was installed consisting of an "American" 2½-in. type DSMD horizontal, single-stage, double-suction, completely bronze fitted centrifugal pump, operated by a 20-h.p., 3-phase, 60-cycle, 220-volt, squirrel cage type 1,800 r.p.m. general Electric motor. In addition to the 3-phase transmission line between the main station and the small auxiliary pumping plant, a single No. 10 iron wire was strung to control the equipment.

In the new pumping plant is placed a Sundh Electric Co.'s control panel for operating the motor. At each end of the control line is a single-pole double-throw knife-switch, so arranged that the equipment can be operated from either end of the line; that is, either from the main or the auxiliary pumping station, by throwing the switch into opposite position. This control, together with the method of priming the pump, is so perfect that the operator need not leave the main pumping station to operate the auxiliary plant so long as the knife-switch on the control panel is in either one or the other position. By throwing the knife-switch in the other direction from the one in which it was not operating, the pilot light would glow, showing the pumping plant was in operation, and so long as the lamp was lighted, he knew the plant was in service. Whenever the water in the elevated storage tank indicated that it was nearly full it was only necessary for the attendant to throw the knife-switch in the opposite position to shut down the pumping plant.



Auxiliary Pumping Outfit of Fort Atkinson, Ohio.

The performance of this auxiliary plant was so satisfactory that during the first month of service it was not visited by the operator in the main station, it being only necessary for an oiler to fill the oil reservoirs three or four times a week. The sub-station at other times operated without attendance and was kept locked.

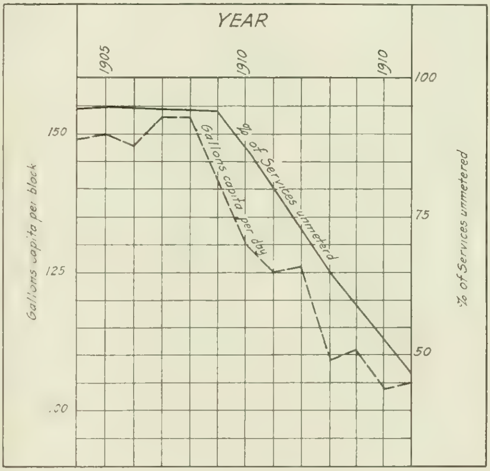
The auxiliary plant when in operation delivers an average of 310 g.p.m. against a total head of 180 ft. at 1,740 r.p.m. with 22 k.w. input indicated at the switchboard. A G. S. flow meter is attached to the discharge of the pump and this indicates that there is an overall efficiency between the power charged to the pumping plant and the net amount of water pumped into the mains of practically 50 per cent. The cost of equipment for this pumping plant was very low, as it is very simple in design and the pump is a single-stage type.

In April, 1916, there were 259 sources of public water supply in use in the State of New Jersey. The water from 59 of these sources is treated before being supplied to the consumer.

Results of Use of Meters in Metropolitan Water District, Boston, Mass.

In 1907 an act was passed by the State Legislature of Massachusetts providing that after Jan. 1, 1908, all cities and towns which derived their source of supply from the Metropolitan Water District of Boston should equip all new service pipes with water meters and also should equip annually with meters 5 per cent of the services that were unmetered on Dec. 31, 1907. The results obtained from the installation of the meters are described by Mr. Samuel E. Killam, Superintendent of Pipe Lines and Reservoirs of the Metropolitan Water Works, in a paper presented at the recent convention of the New England Water Works Association. An abstract of the paper follows.

The per cent of services metered and the per capita consumption per day and at night in each city and town in the district for the years 1907 and 1916 were as follows:



Consumption Per Capita and Percentages of Services Unmetered in City of Boston.

City or town.	Per cent of services metered. Jan. 1, 1907.	Per cent of services metered. Jan. 1, 1916.	Consumption per capita. 1 a.m. to 4 a.m. 1907.	Consumption per capita. 1 a.m. to 4 a.m. 1916.	Consumption per capita. Average daily. 1907.	Consumption per capita. Average daily. 1916.
Arlington	33.6	100.0	50	28	91	59
Belmont	100.0	100.0	31	18	68	52
Boston	5.5	53.2	107	62	153	105
Chelsea	14.6	99.7	59	35	97	68
Everett	2.0	50.0	50	42	82	74
Lexington	2.1	92.0	43	37	69	69
Malden	93.6	95.5	22	28	46	49
Medford	10.5	100.0	65	22	102	46
Melrose	3.9	100.0	85	26	117	45
Milton	100.0	100.0	16	10	46	42
Nahant	17.2	64.1	50	51	130	110
Quincy	14.2	88.6	66	39	100	59
Revere	4.8	70.8	54	34	82	59
Somerville	24.6	69.2	55	34	90	69
Stoneham	1.9	98.5	55	29	91	58
Swampscott	37.8	100.0	41	28	85	59
Watertown	98.3	100.0	36	29	67	65
Winthrop	2.3	100.0	65	26	105	53
District	14.7	66.8	88	51	130	89

The climatic and industrial conditions are immediate factors in considering the difference in the amount of water consumed in the various districts for different years. In Boston the quantity used for business and manufacturing is larger than in any other municipality. The traveling, or suburban, population from outside the city use the water, but is not included in the census population upon which this per capita consumption is based. However, if Boston is divided into various districts, as measured by the master meters, it will be observed that there has been a decided decrease in the per capita consumption in the districts since the installation of service meters.

The following table gives the per capita consumption in gallons for several years in the various districts into which the city of Boston is divided by master meters:

District by services.	1907.	1908.	1909.	1910.	1913.	1916.
Southern Low	118	148	139	128	126	115
Southern High	162	158	151	128	100	105
Charlestown	200	195	186	188	114	113
East Boston	130	140	117	110	58	61
Brighton	132	135	108	107	77	89
West Roxbury	130	131	112	132	92	57
Breed's Island	63	60	61	53	35	31
Total	153	152	143	130	109	105
Per cent of services metered	5.6	5.7	5.8	12.5	34.8	53.2

The southern low-service district comprises the lower area of the city proper, South Boston, Dorchester and Brighton, in which is located the greater part of the business and manufacturing plants, railroad terminals and electric light and power plants. All the other districts are residential, although the southern high-service district includes several of the largest hotels and some business and manufacturing plants. In East Boston and Charlestown considerable quantities of water are used by railroads and shipping, and some by manufacturing plants.

The effect of the use of service meters upon consumption of water is very graphically illustrated by the accompanying diagram showing the daily number of gallons used per capita in the city of Boston and the percentage of unmetered taps for each year, 1904 to 1916 inclusive.

In Melrose, which is largely residential, the reduction due to the installation of service meters was especially noticeable. The introduction of meters was begun in 1907 and on Jan. 1, 1908, about 30 per cent of the takers were changed from scheduled to meter rates and at the end of the year 1908 practically all the services were metered. The records on the master meter showed a saving of 55 gal. per capita in two years, a reduction of 46.7 per cent.

The following table gives the per capita consumption in gallons by months, per cent of services metered in the city of Melrose and the average temperature of the air for the years 1907, 1909 and 1916:

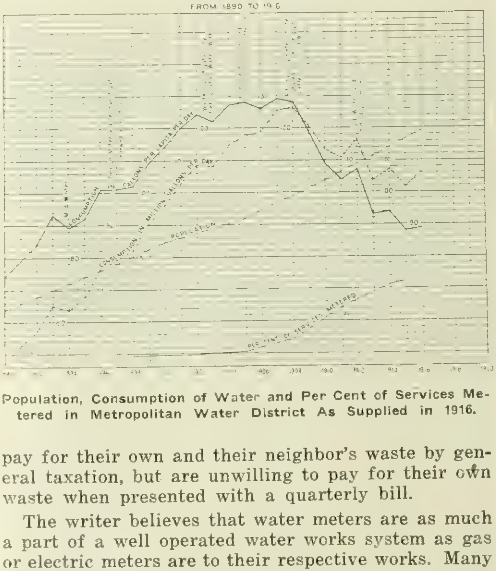
	Consumption per capita.			Average temperature of air.		
	1907	1909.	1916.	1907.	1909.	1916.
January	113	60	43	26.1	29.4	31.6
February	125	61	43	21.6	31.6	24.4
March	116	58	44	37.5	35.2	27.8
April	109	60	43	44.0	48.6	45.6
May	111	63	46	53.7	56.2	58.3
June	120	71	46	64.7	69.4	62.0
July	122	71	45	72.6	70.9	72.6
August	131	66	49	70.0	71.0	71.0
September	116	63	49	64.5	62.7	64.2
October	115	61	47	49.1	52.6	55.0
November	113	60	45	41.7	45.3	41.7
December	115	55	44	34.9	28.4	31.5
Year	117	62	45	48.4	50.1	48.8
Per cent of services metered	3.9	100	100	....	....	....

The daily average quantity of water used in the district in 1916 was 17,808,000 gal. less than during the year 1908, and the per capita consumption has been reduced from 130 gal. to 89 gal., equivalent to over 31 per cent. This reduction in the use of water has been accomplished largely by the introduction of service meters.

If the conditions as they existed prior to 1904 had been allowed to continue additional sources of supply would, without doubt, have been required before the present time. It is also probable that if the act requiring the installation of service meters on all works receiving a supply from the Metropolitan Works had not been enacted it would have been necessary to construct additional works by 1920.

The estimated safe capacity of the Cochituate, Sudbury and Nashua River Works is 173,000,000 gal. per day. It was estimated in the report of the Metropolitan Water and Sewerage Board to the Legislature of 1904 that the cost of new works required within the next 25 years to supply the probable demand for water if the waste was not checked to be at least $32,000,000, assuming that the district remained as constituted at that time.

The greater the quantity of water used the more it costs in the end to furnish water to the tap. At a fixed rate the consumer is charged a certain sum and naturally is not directly interested in leaky pipes as long as no damage is caused by the water. The leaks increase in volume and the quantity of water required for legitimate use is running to waste. Wasted water means larger mains, more pumping machinery, wasted coal and labor and, finally, extension of works for larger supplies and an increased sewer system to care for the wasted water. Many are willing to pay for their own and their neighbor's waste by general taxation, but are unwilling to pay for their own waste when presented with a quarterly bill.



Population, Consumption of Water and Per Cent of Services Metered in Metropolitan Water District As Supplied in 1916.

The writer believes that water meters are as much a part of a well operated water works system as gas or electric meters are to their respective works. Many gas companies account for 80 per cent of gas delivered through the master meters. Well managed water works in Europe account for all but 10 per cent of their supply. Cannot American municipalities do as well?

Waste of water can be divided into two classes—leakage from mains and waste from service pipes. The first can be stopped by efficient management and the latter by enlisting the consumer's co-operation by giving him a direct pecuniary benefit. It appears to the writer that the best way to get results is to sell the water by measure and to keep the measuring devices in good working condition. The writer maintains that the waste which has been stopped in the Metropolitan Water District of Boston by the installation of service meters has deferred for the present the construction of additional works and reduced the cost of maintaining existing works.

Problems of the Modern Waterworks Executive*

The matter of supplying water is of a different character from that of any other municipal industry. All others primarily are disbursing agencies handling allotted funds. Their principal duties are to see that their funds are honestly and economically expended on pre-determined work. The water department, on the other hand, is always a commercial enterprise, similar in many of its requirements to other public utilities, as for example the business of furnishing light and power by gas or electricity and the running of steam and electric plants. Here there is a question both of production and distribution with new problems continually arising as to methods of operation and maintenance. Economical and efficient means must be employed to produce an article that will satisfy customers and be delivered to them at fair rates. The plant must be operated in such a manner as to be at least self-supporting. Thousands of consumers must be handled individually with the same regard as obtains in the best conducted retail trade.

The demands of a modern water supply system are complex and are concerned with matters little dreamed of a generation ago.

Today something more is required of the water works executive than to be able to get 480 minutes' work for the price of labor, properly to lay pipe and quickly to repair a break in a supply main. These things are necessary in carrying on the department work, but they are not the essentials of present day management. The water works executive must be familiar with all these, but in addition he must have intimate knowledge of and ability to handle such financial questions as valuation of works and equitable rate making, as well as hydraulic problems relating to supply and construction or the complexed questions involved in providing a water which satisfies modern standards.

Intelligent systems of accounting are necessary. Rules and regulations adjusted to present conditions are required. Scientific purchase of materials and supplies, cost keeping that instructs, modern transportation, checks on the care of department property, and similar matters are all part of the organization of even the mediocre construction company. How can water department business succeed without them?

The question of revision of rates to meet existing conditions is most vital to successful operation, but one which is often the last to be taken up, particularly in municipally-operated plants. Many rate schedules now in use even in our larger cities are inheritances of the past, continued because of the inertia of the present. Some of these are ridiculously inadequate and fail utterly to recognize conditions of plant, cost of operation, and special value to different classes of users. Such conditions result in extravagant operation and in ineffectual service.

At the present time it is the trend of opinion, based on judgment of the best sanitary specialists, that all public water supplies sooner or later must be filtered. Water is demanded which is clean and attractive from pollution, removal of turbidity and color, reduction of chemical constituents producing hardness and other detrimental conditions, and the elimination of taste and odor.

These are some of the problems of the modern water works executive. Properly met, they mean efficiency in organization and economy in operation with consequent benefit to the city. To do these things it is necessary that the manager of the water department shall be able to grasp, understand and control adverse conditions which were formerly accepted as inevitable, but are now known to be amenable to remedy if not cure.

The past experience of this association with its avoidance of entangling alliances is the best guide we can have for the future. Our present position as a power in water department matters shows clearly the wisdom of the founders of this association in rightly excluding both politics and commercial exploitation from its voting membership.

With other organizations we will work together gladly and we welcome all water works men to our membership. Careful consideration of our own particular needs and purposes, however, forbids any thought of combination with others. In these critical and serious times it is well for us to cultivate the attitude of the open mind and the spirit of co-operation.

One of the most cogent reasons why our manufactured products, up to the war period, had so little market in Central and South America was the arbitrary stand of American producers as to details of construction and methods of packng goods, regardless of the needs of the purchaser. Until many of our manufacturers and consumers, on the one hand, emerge from this attitude of pigheadedness, and on the other step aside from a position of cock-sureness, there will be difficulty in meeting the demands of commercial enterprise and construction possibility. Opportunity is hindered by ignorance and the effect of the small mind, unable to comprehend the standpoint of the other fellow. The talisman of success is "Co-operation." Manufacturers must concede the necessity and be willing to consider with open mind changes in plant, though expensive to them, if efficiency and economy result in construction work.

Engineers and users of manufactured products must recognize business exigencies and matters affecting established industry. They, too, must have the open mind which is free from personal bias, broad in its outlook and dispossessed of a finicky attitude. In the "get-together" atmosphere of this convention let us all try to get into touch with the real reasons for the differences between users and producers and see if we cannot reach some mutually advantageous ground in advance of that on which we now stand.

In these days the direction of the force of gravity as regards cost of labor and materials appears to have been reversed. An efficient way and perhaps the best way to meet this conditon seems now to be the more general use of labor-saving tools, careful selection of materials, more thoughtful planning of work and better organization force. Present prices of labor and materials in many cases are beyond that ever before experienced, and the outlook into the future seems to reveal little or no downward tendency. For a short period there seemed to be a faltering in construction work, but contract news, construction advertisements, and bond sales indicate recovery with a tendency to accept present prices as better perhaps than will be afforded later. From this viewpoint, more and more public work of considerable magnitude is being let. With the reduction of labor due to national requirements and the possibility of greater demands for materials, even if peace should come quickly, there seems to be greater chance for increasing cost of work for some time to come.

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*Abstract of presidential address of Mr. Caleb Mills Saville at 36th annual convention of the New England Water Works Association.

Methods Used at Cincinnati Filtration Plant for Isolating and Identifying Bacillus Coli

As a result of an improved method of examination for the Bacillus Coli adopted in 1916 by the Water Works Department of Cincinnati, O., the data obtained are believed to be more reliable and their significance for interpretative purposes more trustworthy. The method is described by Mr. Stephan J. Hauser, Chemist of the Filtration Division, in the last annual report of the Water Works Department, from which the matter following is taken.

The B. Coli group may be defined as aerobic non-spore forming Gramnegative bacilli, fermenting lactose with production of gas, and not liquefying gelatine. At the Cincinnati filtration plant the attempt is made to carry out the examinations so that the above definition is fulfilled as completely as possible, consistent with the speed and facility necessitated by routine water analysis.

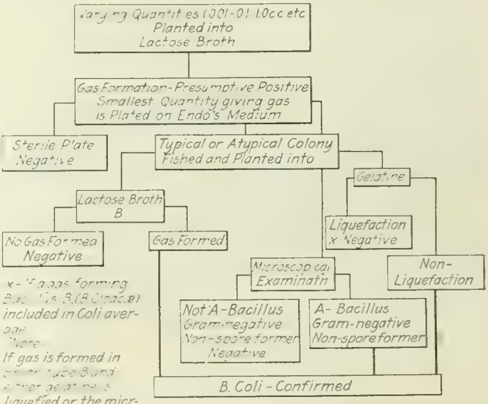
The particular water samples under examination are planted into lactose broth. Lactose broth is used rather than lactose bile, which is the medium recommended in the 1912 edition of the Standard Methods of Water Analysis of the A. P. H. A., for the reason that, not only at this laboratory, but at the laboratory of the Ohio River Investigation of the United States Public Health Service and other laboratories, it has given consistently a higher percentage of confirmed end-results from original inoculations. In planting the water sample decimal dilutions are used to facilitate computations of the B. Coli index. In routine examinations, at least three dilutions are used in order to obtain, if possible, a negative and a positive test. The formation of gas in any amount after 48 hours incubation at 37° C. is recorded as positive and considered as presumptive positive. The smallest quantity of water giving gas is then confirmed.

A loopful of culture from the tube furnishing the presumptive test is stroked upon Endo's medium previously poured in plates. The plates are incubated at 37° C. for 24 hours. If no aerobic colonies (sterile plate) develop, the respective gas formation is considered due to anerobes, and B. Coli is recorded as not present. If aerobic colonies develop, the most typical of B. Coli is transplanted into latose broth and gelatine and a microscopical examination made directly. As there are several varieties of typical B. Coli colonies, experience alone will determine the choice.

If in the lactose broth transplat, no gas is formed after the 48 hours at 37° C., the result is considered negative, and B. Coli is recorded as not present. If gas is formed the result is considered positive for B. Coli, subject to the results of the gelatine transplant and a microscopical examination. If after 48 hours' incubation at 37° C. the gelatine transplant will solidify on cooling, the culture is considered as non-liquefying. If the gelatine does not solidify on cooling, and, gas is formed in the lactose broth transplant and the microscopical examination demonstrates a bacillus, the organism is called B. Cloacae and included in the B. Coli numerical estimation as it has the same sanitary significance.

The microscopical examination consists of a smear made according to the method of Gram from the Endo plate colony selected for transplanting. A Gram-negative non-spore forming bacillus obtained following the above procedure fulfils in every particular the definition for the Bacillus Coli. If other than a Gram-negative non-spore forming bacillus is obtained, it is not considered B. Coli and is so recorded, but such a result is unlikely and has not been encountered in experiences at Cincinnati. The liquefaction of gelatine and discordant results in the microscopical examination accompanying gas production in the lactose broth transplant are likely to be due to mixed cultures, in which case separation should be made by replating from the lactose broth transplant.

Estimation of the B. Coli index is made according to Phelp's method—that is, the reciprocal of the smallest volume of water which gave a positive test is taken as the approximate number of B. Coli per c. c. and is recorded as such. In case of an anomaly it is assumed that the positive result should have been negative and the negative result positive and is so considered in obtaining the B. Coli index. If a negative confirmation test is obtained, B. Coli is considered present in the next larger quantity without confirmation. If a negative result is obtained from the largest quantity planted, either by no gas formation in the original planting or by a negative confirmation test, B. Coli is considered present in the next larger amount that would have been planted, except that a negative result in 100 c. c. is recorded at zero. The assumption is valid only in the case of waters such as are encountered in water purification plants where the approximate coli content of the water is known. Such assumptions are rarely necessary as the quantities of water chosen for examination can ordinarily be changed in sufficient time to always obtain a positive test. It is probable that this assumption causes less error than would be introduced by either omitting the figure from the averages or calling it zero.



x—If a gas forming Bacillus B. (B. Cloacae) included in Coli average.

Note.

If gas is formed in broth tube B and either gelatine is liquefied or the microscopical examination shows organisms other than bacilli (non-spore forming, gram stain negative) then a replate is made from broth tube to insure pure culture, and started again at A.

Method Followed at Cincinnati Filtration Plant for Identifying B. Coli.

The laboratory work above described with the numerical estimations of B. Coli derived, are recorded for the month under headings of waters in the consecutive stages of purification. The form used is convenient and compact and lends itself readily to a grasp of conditions throughout the plant at any time. Five days from the collection of the water sample, B.

Coli may, following the above scheme, be satisfactorily and conclusively isolated and identified to conform to the definition.

The following table will show the number of samples examined, according to this method, from January to October, 1916, and the percentage of samples confirmed as B. Coli.

				Filtered water.	
	River water.	Settled water.	Applied water.	Effluent from filters.	Outlet clear water reservoir.
Samples tested........	271	257	266	258	194
Percentage confirmed..	97.4	91.0	96.6	*94.9	*86.1

*Includes one sample that showed B. Cloacae

Mechanical Filter Bottoms and Strainer Systems

An interesting discussion of the development of strainer systems was presented by Mr. Robert Spurr Weston, Consulting Engineer, Boston, Mass., in a paper presented at the recent convention of the New England Water Works Association. An abstract of the paper follows:

The simplest and perhaps the earliest form of strainer system was a perforated metal plate. This is used no longer except for small filters. The next step in advance was to screw strainers or "sand valves" directly into the perforated metal plate. There have been many kinds of strainers. The early ones were made of fine, perforated metal or wire cloth supported by a suitable brass casting. Later strainers were provided with drilled or punched holes or sawn slots. Most of the openings in these earlier strainers had a diameter or width of less than 0.1 mm.

In the earlier filters the sand rested directly upon the strainers, with the result that the fine perforations clogged quickly, making extensive and frequent repairs necessary. The remedy was to enlarge the perforations in the strainer and to place above the same a layer of graded gravel about 6 in. in thickness. This prevented the sand from reaching the strainer and clogging did not occur. About the same time it was found that in the space below the false bottom the velocities of flow were so low that sand and coagulated matter accumulated, thereby furnishing a pabulum for the growth of bacteria. Therefore, notwithstanding the fact that the false bottom type of filter was ideal for the distribution of wash water, a pipe manifold was substituted for the false bottom in order to maintain higher velocities in the underdrains.

The early filters were circular and were equipped with revolving rakes to agitate the sand during washing. Wash water velocities of less than one vertical foot per minute were used. Later (about 1893) the air agitation system was introduced by the Continental Filter Co., thus permitting rectangular construction and concrete filters. The rakes were abandoned soon after.

The Little Falls plant, put in operation in 1903, typifies the best practice of the time. The strainer consisted of a perforated metal cap attached to a threaded fitting from which a small tube depended. In one side of this tube, near the fitting, was a small hole through which air passed for the purpose of agitating the sand layer. The dependent tube formed a trap so that the strainer could be used for both air and wash water distribution. This strainer system has been fairly successful, although it may fail to prevent hard spots in the filter from time to time and especial cleanings of the filtering material may have to be made. Low wash water velocities were employed and air agitation was necessary.

The next large filter plant to be built was the one at Cincinnati, which was put in operation in 1907. This marked a new departure in that air agitation was done away with and a wash water velocity of 22 vertical inches per minute was found to be necessary for the perfect cleansing of the sand. The strainer system consisted of perforated plates covering concrete channels located at the bottom of trough-like depressions running lengthwise of the filter. The troughlike depressions were filled with gravel and to prevent its displacement during washing wire cloth screens were bolted to the tops of the troughs. These retained the gravel effectively and prevented the passage of sand into the filters, but it has been found that they corroded in certain waters, notably at Cincinnati, and recently they have been removed and the necessity for their use avoided by increasing the depth of gravel above the strainers to 14 in.

The Cincinnati type of filter bottom, while efficient, is quite expensive, and the next step was to secure the same results for a lower cost. The strainer system used at Harrisburg, Pa., consisted of a pipe manifold on the under side of which holes were drilled. The pipes composing the manifold were 1¼ in. in diameter, laid 6 in. apart, and drilled with 7/32-in. holes spaced 3 in. center to center. In this filter air was used for agitation. Somewhat later filter bottoms of the Harrisburg type, in which the use of air was omitted, the velocity of wash water increased and the gravel layer deepened to 14 in. or more, were used, probably first by Philip Burgess, C. E., of Columbus, O. A similar form used at Toledo and Youngstown O., both of which plants were built by the Norwood Engineering Co., consists of the ordinary pipe manifold into which star-shaped strainers of the Wilson type were screwed. The Norwood Engineering Co. has always believed in air agitation and all of their filters are constructed with this end in view. Nevertheless, there is no reason why this type of filter bottom may not be used without air agitation, provided the strainer openings are enlarged, the gravel layer deepened and the wash-water velocities increased to the optimum for the sand employed.

The next was the so-called Wheeler filter bottom, consisting of inverted pyramids filled with 3-in. spheres and marbles, covered with a layer of gravel 6 to 8 in. in thickness. A series of channels corresponding to the pipe manifold communicate with the orifices of the respective pyramids. The advantages claimed for the Wheeler filter bottom are the better distribution of wash water secured by uniform material uniformly placed; the absence of metal in contact with the water, thereby increasing the life of the bottom; and its lower cost.

Probably the newest and yet the oldest type of filter bottom is that exemplified at Alliance, O.; Muncie, Ind., Warren, Pa., Shreveport, La., and Erie, Pa. This consists of a false metal bottom into which brass strainer nozzles are screwed, spaced 6 in. apart. It is the false bottom of the earlier design, but the strainers with fine openings have been replaced with those having large openings. The gravel layer has been deepened and wash water of high velocity is used. False bottoms of concrete have been suggested and have been built at Miraflores, C. Z., and at East Liverpool, O., but the difficulties in the way of the successful design of a tight structure of this kind have caused conservative engineers to avoid it. Furthermore, it is believed that the space beneath the false bottom is a disadvantage, as mentioned above.

Mr. William Wheeler is now building for The Winchester Water Works Co. (Ky.) a filter bottom having the usual pyramids and balls but instead of channels beneath the pyramids there is a rectangular space like beneath the filters mentioned above.

The most generally satisfactory strainer systems are the following:

1. Manifolds, strainers and a 14-in. layer of gravel.
2. The Harrisburg system of perforated pipes with a 14-in. layer of gravel.
3. Troughs having strainers at their bottoms, with a 14-in. layer of gravel.
4. The Wheeler filter bottom with 7 in. of gravel.

All of these systems should be designed to wash the sand layer without the use of air. Each system has its advantages and disadvantages, but the excessive cost of system No. 3 makes its use inadvisable. There are, therefore, three systems left. Of these system No. 2, the Harrisburg system, is the simplest. It, however, consists largely of metal, all of which is exposed, and at the present prices is probably more expensive than the Wheeler filter bottom. System No. 1, like that installed by most of the filter companies, possessed the advantage over System No. 2, the Harrisburg system, of having the outsides of the pipes protected by concrete. The strainers, however, are exposed and must be constructed of bronze, which at present prices makes the installation costly, probably the highest of the three. The inside of the pipes are likewise exposed.

In either of the above systems there exist "dead" spaces on the floor of the filter between the openings where the wash water does not readily reach. This difficulty is overcome in Systems No. 3 and 4, of which No. 4, the Wheeler filter bottom, is the cheaper. The advantages of the Wheeler filter bottom consist in the absence of metal (with the exception of the short brass tube at the apex of the pyramid); the nearly perfect distribution of the wash water secured by the "ball nozzle" effect of the balls; the lower cost, and the thinner gravel layer. The writer believes that the Wheeler filter bottom is best when placed above channels rather than built as a false bottom of the filter, although to construct the latter is perfectly feasible.

Considerable difficulty has been experienced with the Wheeler filter bottom at Akron because of sand passing through the gravel around the walls of the filter, particularly at the corners. The writer has investigated this filter and found that there was a ledge 1-in. wide left around the walls of the filter and furthermore the gravel was composed of 1.5 in. layers and had a total depth of 6 in. It was very difficult for the workmen to spread 1.5 in. layers of gravel evenly in the large units (2,000,000 gal. daily); consequently the sand had passed through the gravel in certain places until it rested on the ledge around the walls of the filter. This sand remained inactive. The difficulty was overcome by increasing the thickness of the gravel layer around the walls of the filter, particularly at the corners. Less than 0.5 per cent of the area of the filter was involved. This is a very low percentage of sand surface out of action because of lumps, hard spots, etc., and the difficulty can be readily overcome. It would probably be best in a new filter with this bottom to make the gravel layer 8 in. in thickness,—namely, 4 in. coarse gravel, 2 in. medium gravel and 2 in. fine gravel, rather than 3 in., 1½-in. and 1½ in., respectively, first used. Where the filter area is small, the thicknesses of the gravel layer may be reduced to those last given.

In large filters there seems to be a tendency towards wave motion in the underdrains, which may accumulate pressure at certain points in the filter bed, particularly at the ends of the channels, and may possibly cause the rupture of the gravel layer if it be too thin. This statement of course applies equally well to the three systems under consideration. The Wheeler filter bottom is better designed to resist jet action from the strainers than are either of the others. The effect of a large ball immediately above the orifice is absolute and unchangeable.

The discussion regarding choice of filter bottom at present centers around the relative merits of the false bottom and the strainer or manifold type. The false bottom was used in the Miraflores (C.Z.), Erie and other plants, but only a few plants have been so built. The fear in the minds of operators of filter plants is that they may not prove so efficient bacteriologically as a plant designed on the other plan. On the other hand, the false bottom approaches nearer the condition for successful washing,—namely, that of a series of orifices discharging from a tank,—but with underdrain channels of sufficient size, relative to the areas of the orifices discharging from them, good enough distribution may be secured for all practical purposes, and the dangers, both structural and in operation, which the false bottom presents, avoided. There should be no objection to the use of the false bottom in small filters.

Thirty years' experience and the results of experiments by Ellms and others, indicate that the successful filter will be washed at a high velocity with water alone. This effect is best secured by a strainer system consisting of orifices, above each of which is placed a layer of graded material to prevent sand from passing out of the filter, either when filtering or washing.

The underdrain system should be designed to throttle the discharge of wash water the orifices. The latter should be reasonably large to avoid unusual loss of head in the filter, and the underdrains should be proportioned to the orifices. The false bottom system, while cheaper, is not so reliable as the other systems, and there are more or less troublesome results from cast or wrought iron headers and manifold strainer systems, even when they are cheaper, which is rarely the case. The Wheeler bottom, with sufficient gravel, best fulfills the conditions of practice. It is, however, on account of its being a patented device, more expensive than the Harrisburg system. On the other hand, it is more durable.

The number of undergraduate students registering in the College of Engineering of the University of Illinois up to Oct. 1 was 864. Of this number 151 were in the Civil Engineering Department.

Tests made public recently by the U. S. Bureau of Mines show that the amount of deterioration of coal in heating value during storage has commonly been overestimated. Except for subbituminous Wyoming coal, no loss was observed in outdoor weathering greater than 1.2 per cent in the first year, or 2.1 per cent in two years.

The Position of Engineer in the Community and His Relations to the Contractor*

The engineer is primarily a man whose life is devoted to promoting and planning things that actually happen, and without doubt he is slowly but surely assuming his rightful position in the world, because it is becoming universally recognized that he, above all of his fellows, is better fitted by his education, experience, and, generally, his temperament to fill those positions in the direction of the world's material progress which require, among other things, sound, sane and intelligent judgment and at the same time administrative ability, energy, technical and scientific knowledge of a high and varied order.

Of course, initiative, candor, truthfulness and efficiency, and, above all, integrity, are presupposed and let us hope can usually be taken for granted.

Engineering is an art and a science. It is a science in so far as certain physical laws are its basis. It is an art in so far as in the application of these laws the best judgment inherent in or acquired by man must be exercised. It is the engineer who is the pathfinder and pacemaker in modern civilization, and it is he who more nearly than any other individual can be likened unto Jove of old, whose command of the elements used to be universally acknowledged and is proverbial, and it is the engineer who, today, is largely charged with encroaching on his ancient and honorable preserve.

Little progress would be made in the modern world if the engineer did not blaze the way, and a giant's share of the progress in material things which has been made since the birth of the First Napoleon has been made by engineers, and incidentally it may be observed that, since his birth, there has been more actual progress than was made during two thousand years that preceded it. That there is far more difference between our world and that in which Bonaparte was the central figure than there was between his world and that of Julius Caesar, most of which difference has mainly been brought about by the engineer, cannot be disputed. Much yet remains to be accomplished. Unknown and exhaustive domains no doubt are still to be explored and exploited, but, stupendous as is the task, the engineer will, when the day of reckoning arrives, be found to be in the forefront.

To cope with those impediments which Nature and man set up in the way of material progress, and to transmute or convert these into processes for the use and convenience of mankind, is the acknowledged function of the engineer, and he has not heretofore been, nor shall he in the future be, found wanting.

To be more specific, in the ultimate analysis the elemental components, physical, mental and moral, which in the ensemble constitute the engineer, as herein stated, may be said to be character and experience, imagination, efficiency, executive and technical ability and scientific knowledge. While no one of these principles can be said to dominate the rest, still in a general sense there is no disputing the fact that character stands first. It is the framework or foundation on which the other characteristics are built.

Technical ability and scientific knowledge are not written first because it is thought to be of little importance, but because ultimately the other principles being broader have a bigger bearing on the resultant man.

A man may be a great engineer with only sufficient scientific knowledge to eliminate the impossible and whose sole characteristics are his imagination, ingenuity, and experience, but who possesses a mind capable of conceiving or forecasting and in rare instances defining the desirable and necessary (as the case may be) in the human economy. Such was the elder De Lesseps, James J. Hill, Harriman, Carnegie and a host of others among the pioneers in industry on this continent.

Imagination is to be interpreted as broad vision, creative ability. Technical ability considers scientific knowledge applied in the light of experience, reason and common sense. Efficiency is generally defined as the ratio of the work expended to that produced and in a larger sense is the process of effectively correlating all of the operating forces and energies in one unit for economical production. Executive ability is the process of successfully commandeering and utilizing the services of others.

The provinces of engineering and economy are often intertwined to such an extent that it cannot be said distinctly just where one ends or the other begins. Engineering which is not economical is not good engineering, and economy which will not bear rigid scientific investigation or treatment, such as an engineer would subject it to, is not economy.

Where we attempt a rigid mathematical analysis in any instance, we must be sure of the premises, and it should be remembered that scientific analysis does not necessarily mean mathematical precision to the exclusion of the broader judgment based on experience and common sense.

An engineer's education after it reaches a certain stage should be along broad lines, to include the humanities, so as to fit him for leadership.

A knowledge of men which the old school believes can only be had by contact, but which some now seem to think can be obtained through the mastery of what has been called the Science of Character Analysis of Dr. Blackford, is more to be desired than a knowledge of integral calculus and by all odds gives one a better chance in life.

Many engineers are of necessity employed by industrial and commercial organizations. Some are born to lead and others to serve—in whatever class we find ourselves it is up to us to do our utmost. To be able to intelligently and successfully carry out orders is a faculty not to be despised and, by the way, it is not the easiest task imaginable.

An engineer's actions should be guided solely by the Golden Rule, and equity, not policy; that is, strict justice, rather than law, should govern. In his relations with the contractor he occupies a sort of judicial position, and must possess great discriminating powers and must appreciate point of view.

It is better to be right and to act justly, even if appearances are against you, than to be guilty of a wrong, even with appearances in your favor.

In his relation to his employers it goes without saying that they are the sole judges as to his ability and fitness. In his dealings with them he must possess candor and ability to look out for their interests without sacrificing his own. It is a fact that is not to be disputed that he must be true to himself, first, and that he must not forget or overlook his own interests.

To become so absorbed in your work as to be oblivious to one's own interests is not demanded by any of the precepts or the examples that we have of the greatest of our professional brethren, and it can rightfully be said that disloyalty is a crime, whether to one's self or to one's employers or clients.

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*From a paper by S. M. Swaab, M. Am. Soc. C. E., in the September Proceedings of the Engineers' Club of Philadelphia.

In every instance the contractor should receive a square deal at the hands of the engineer and in no instance should the engineer have it in his mind to get square with the contractor for some fancied or even real act of omission or commission. Those who have had sufficiently broad experience recognize that specifications are intended to be interpreted in the spirit, rather than in the letter. As Theodore Cooper, in his day recognized as the foremost bridge engineer in this country, put it, "The best system of rules to insure success must be interpreted on the broad grounds of professional intelligence and common sense."

Constant bickering, indicating lack of poise and persistent petty fault-finding without being able to offer suggestions for the betterments of conditions, is the method pursued by many young engineers to the detriment of the work on which they are engaged.

There is absolutely no reason why the most cordial relations should not exist between the contractors and engineers engaged on the same work and there are probably the very best of reasons why they should, as their interests are alike.

The specifications are often the rock on which the cordial relations of the engineer and the contractor are rent asunder.

Contractors, like engineers, are actuated by the same motives as other men. The engineer may or may not be superior to the contractor, but he cannot show his superiority by taking undue advantage of him.

Contracting, according to the usual methods in vogue, of which some one has aptly said, "The profits are limited by competition, but the losses may be unlimited," should no longer prevail, but as it is or should be a legitimate business, the gambling element should be removed therefrom, and should certainly not exist to a greater extent than it exists in any other ordinary business.

Contractors would be better men as well as better contractors if their remunerations were fixed, rather than problematical as is usual.

The party for whom the work is being done should take all of the incumbent risks, and then any incentive of the contractor to take advantage is removed.

Some specifications deliberately give the engineer the whiphand, but it has been determined in the courts of this country that it cannot be employed without considerable danger. As engineers we know that the action and reaction are equal.

Clauses which have a double meaning or which can be interpreted in two ways should not be written in specifications. A contract represents a meeting of the minds of the contracting parties. The engineer should not attempt to protect himself by inserting obscure clauses in specifications whereby he may cover up his own ignorance or shortcomings at the expense of the contractor.

Copying clauses from one specification into another without fully understanding their meaning, simply because they are time honored, i. e., because custom has sanctioned them, which is not unusual, is a very silly and at the same time dangerous practice.

Few men have ever been vested with considerable power who haven't at times abused it, and the engineer who prepares the specifications and who interprets them and who in the case of dispute has the last say, in fact is the "sole arbiter," has to be a bigger man than the ordinary to be absolutely unbiased. In the case in question the engineer is judge, jury and prosecuting attorney, all welded into one, and the one who usually suffers, and to whom is meted out the punishment, unless the engineer happens to be a very big man, is the contractor.

High Pressure Fire Protection System of Toledo, O.

A high-pressure fire protection system covering 140 acres of the congested value district of Toledo, O., was placed in service early this year. The pumping station is located on the Maumee River, the supply being taken from the river through two screened intakes into two wells connected by a 36-in. pipe. The wells and cross connections are controlled by sluice gates.

The normal lift is about 8 ft. with a possible maximum of 16 ft. The discharge from the station is three two 16-in. lines, each line being equipped with a venturi meter. Two motor-driven air pumps are provided for priming with an automatic control.

The station is directly connected with the fire alarm system and all alarms received in the district are transmitted to station upon receipt. Operators upon receipt of the alarm start the pumps and maintain a pressure of 175 lb. at beginning, increasing same upon receipt of order of Fire Department officials.

View in Rear on River Side of High Pressure Fire Service Station.

The equipment was built by the Allis-Chalmers Manufacturing Co., and consists of four 10-in., 5-stage, horizontal, centrifugal pumps, each with a capacity of 2,000 gal. per minute, against a pressure of 300 lb. The pumps are direct connected to 550-h.p., 3-phase, 25-cycle, 4,000-volt motors. Space is provided for two additional units.

Each pump takes suction through a 10-in. line equipped with a check and gate valve and by-passed to the suction through a 10-in. regulator valve having a range of 100 to 300 lb. Suction and discharge valves are motor operated and the latter have 2-in. by-pass.

Auxiliaries, station lighting and control of starting and operating mechanism of the pumps are dependent upon 110-220-volt direct current. A motor generator set operated from the 4,000-volt circuit and generating 125-250 volts is provided for emergency use.

The station building is two story and basement entirely fireproof, being 65x90 ft. in plan, with bearing walls of bricks and floors of reinforced concrete. The operating floor has tile wearing surface. All windows are wired glass in metal frames.

The cost of the completed staton was as follows: Lands, \$20,000; substructure, \$50,548; superstructure, \$57,541; machinery and equipment, \$62,423; electrical equipment, \$410; making a total cost of \$190,924.15.

Power is secured from the Toledo Railways & Light Co. and is purchased by contract covering a period of five years. The contract requires that 500 k.w. at the bus bars or sufficient current to operate one pump must be available immediately and at all times, additional current for all remaining pumps must be had within five minutes' notification.

The distribution system comprises 4,825 ft. of 16-in., 2,250 ft. of 12-in., and 15,550 ft. of 10-in. mains. All pipe is tar coated cast iron and is Class G of American Water Works Association specifications. When installed most all sections were tested under a water pressure of 425 lb.

The gate valves on the mains are set in masonry vaults with iron covers and those on hydrant branches are operated through extension boxes; all covers are specially marked. The 16-in. valves are by-passed and geared. The system supplies 67 Matthews post hydrants, each with 8-in. gated branch and 12-in. barrel with four, independently gated 3½-in. outlets which have double caps reducing to 2½ in. Of these hydrants, 47 are located within the congested valve district and have a linear spacing of 300 ft. and an average area served of 83,300 sq. ft.

Effect of Mouthpieces on Flow of Water Through Submerged Short Pipe

An investigation has been completed by the Engineering Experiment Station, University of Illinois, under the direction of Fred B. Seely, Associate in Theoretical and Applied Mechanics, to determine the effects of mouthpieces upon the flow of water through a submerged short pipe. The experiments involved the use of a cast iron pipe 22½ in. long and 6 in. in diameter, bored to a smooth surface. Cast iron conical mouthpieces of different lengths and angles were used. The results of the investigation are set forth in detail in a bulletin issued last month by the Engineering Experiment Station. The conclusions drawn from the experiments follow:

As applying to conditions likely to be met in engineering practice, the value for the head lost at the entrance to an inward-projecting pipe (i. e. without entrance mouthpiece and not flush with wall of the reservoir) is 0.62 of the velocity head in the pipe $(0.62 \frac{v^2}{2g})$ nstead of $0.93 \frac{v^2}{2g}$, as usually assumed. To put it in another form, the coefficient of discharge for a submerged short pipe with an inward-projecting entrance is 0.785 instead of 0.72 as given in nearly all books on hydraulics. Further, the lost head at the entrance to a pipe having a flush or square entrance is 0.56 of the velocity head in the pipe $(0.56 \frac{v^2}{2g})$ instead of $0.49 \frac{v^2}{2g}$ as usually assumed. In other words, the coefficient of discharge for a submerged short pipe with a flush entrance is 0.80 instead of 0.82 as given by nearly all authorities.

The loss of head resulting from the flow of water through a submerged short pipe when a conical mouthpiece is attached to the entrance end, may be as low as 0.165 of the velocity head in the pipe $(0.165 \frac{v^2}{2g})$ if the mouthpiece has a total angle of convergence between 30 and 60° and an area of ratio of end sections between 1 to 2 and 1 to 4 or somewhat greater. In other words, the coefficient of discharge for a submerged short pipe with an entrance mouthpiece as specified above is 0.915.

The loss of head which occurs when water flows through a submerged short pipe having an entrance mouthpiece varies but little with the angle of the mouthpiece if the total angle of convergence is between 20 and 90° and if the area ratio is between 1 to 2 and 1 to 4 or somewhat more. The loss of head for any mouthpiece within this range would be approximately 0.20 of the velocity head in the pipe $(0.20 \frac{v^2}{2g})$. There is, therefore, little advantage to be gained by making an entrance mouthpiece longer than corresponding to an area ratio of 1 to 2. Thus, an entrance mouthpiece with a total angle of convergence of 90° and the length of which is only 0.2 of the diameter of the pipe gives approximately $0.20 \frac{v^2}{2g}$ for the loss of head.

The amount of velocity head recovered by a conical mouthpiece when attached to the discharge end of a submerged short pipe depends largely upon the angle of divergence of the mouthpiece, but comparatively little upon the length of the mouthpiece. This is true for lengths greater than that corresponding to an area ratio of 1 to 2 and for total angles of divergence of 10° or more. The amount of velocity head recovered decreases rather rapidly as the angle of divergence increases from a total angle of 10 to 40°. At or near 40° the amount of velocity head recovered rather abruptly falls to approximately zero.

A conical discharge mouthpiece having a total angle of divergence of 10° and an area ratio of 1 to 2, when attached to a submerged short pipe, will recover 0.435 of the velocity head in the pipe, which is 58 per cent of the theoretical amount possible of recovery.

The amount of velocity head recovered by a diverging or discharge mouthpiece when attached to a submerged short pipe is considerably more when a converging or entrance mouthpiece is also attached than it is when the entrance end of the short pipe is simply inward-projecting (no mouthpiece attached). This excess in the velocity head recovered diminishes rather rapidly as the angle of the discharge mouthpiece increases, and it becomes zero for a discharge mouthpiece having a total angle of divergence of approximately 40°. This increase in the velocity head recovered is probably due to the effect of smooth flow in the pipe as the water approaches the discharge mouthpiece. The smooth flow allows the mouthpiece to recover more of the velocity head in the pipe than when a more turbulent flow exists; this increase amounts to as much as 33 per cent in the case of the discharge mouthpiece having a total angle of divergence of 10° and an area ratio of 1 to 2.

Trench Pressures Upon Sewer Pipe

The accompanying table giving safe trench pressures for sewer pipe for sand and for wet clay ditch filling materials, was submitted at the last annual convention of the American Society for Testing Materials by Committee C-4, of which Mr. Rudolph Herring is chairman, as a proposed tentative specification for trench pressures upon sewer pipe. The table has been prepared for a safety factor of $1\frac{1}{2}$, which has been found necessary to prevent cracking from the loads of ditch filling.

TRENCH PRESSURES FOR SEWER PIPE, IN POUNDS PER LINEAR FOOT.

Height of fill above top of pipe, ft.	Breadth of ditch a little below top of pipe. 1 ft.		2 ft.		3 ft.		4 ft.		5 ft.	
	Ditch filling material.		Ditch filling material.		Ditch filling material.		Ditch filling material.		Ditch filling material.	
	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.
2....	220	235	510	530	805	825	1,105	1,125	1,405	1,425
4....	335	375	880	935	1,455	1,520	2,045	2,115	2,635	2,710
6....	390	455	1,140	1,250	1,975	2,105	2,840	2,980	3,715	3,865
8....	420	505	1,335	1,490	2,395	2,595	3,515	3,745	4,660	4,910
10....	440	535	1,470	1,680	2,730	3,010	4,085	4,410	5,490	5,850
12....	445	550	1,565	1,825	3,000	3,355	4,570	5,000	6,220	6,695
14....	450	560	1,635	1,935	3,215	3,650	4,980	5,515	6,855	7,460
16....	455	565	1,690	2,020	3,385	3,895	5,330	5,970	7,410	8,145
18....	455	570	1,725	2,085	3.525	4,100	5,625	6,360	7,900	8,770
20....	455	575	1,750	2,135	3,640	4,275	5,875	6,715	8.330	9,325
22....	455	575	1,770	2,175	3,725	4,420	6,090	7,020	8,705	9,830
24....	455	575	1,785	2,205	3,800	4,545	6,270	7,290	9,035	10,285
26....	455	575	1,795	2,230	3,855	4,645	6,420	7,530	9,325	10,690
28....	455	575	1,800	2,245	3,905	4,735	6,550	7,735	9,575	11,060
30....	455	575	1,805	2,260	3,940	4,805	6,660	7,920	9,795	11,395
Very great	455	575	1,820	2.310	4,090	5,190	7,270	9,230	11,365	14,425

News Letter

St. Louis Items.

Harrington Bros. secured a job of team work on a coal line at Sessor, Ill.

T. P. Newland moved his outfit on to a piece of Chicago & Alton work in Venice, Ill.

Lameroux & Terrace have their outfit at work on state aid roads south of Lincoln, Ill.

Smith & Hannan have sublet their team work on the Wabash R. R. at Forest, Ill., to O. E. Shobe.

Frank P. McCaughey was in from Christopher, Ill. Reports skinners a little scarce down his way.

McMillan Contracting Co. was awarded an additional contract by the North Western R. R. near Benld, Ill.

R. E. Blan, 908 W. Gate St., St. Louis, has 3 teams that he wants to place on some railroad job near the city.

Capt. A. W. Farney is putting in some revetment and shore protection work for the American Ore Co., at Bouxippi, Ark.

L. C. Martin of Martin Bros. was in the other day looking up work for their 10-team outfit. 100 W. Broadway, East St. Louis, Ill., will catch him.

The Missouri Valley Construction Co. is doing some mat and revetment work on the Mississippi River near the Chain of Rocks for the city of St. Louis.

Tim Maloney of St. Louis put in the lowest bid for 65,000 yards of property grading that is being done by the Morris Realty Co. of Granite City, Ill.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

M. C. Connors & Co., 610 W. Madison St., have 30,000 yd. of machine work on the Burlington R. R. near Peoria, Ill., to sublet. This is a nice piece of work, mostly all short haul.

Maney Bros. report their work on the Santa Fe R. R. between Caney, Kansas, and Pawhuska, Okla., as getting along nicely with the exception of being a little short of labor. They have enough work there to hold them for a year.

L. J. Smith of the L. J. Smith Construction Co. in addition to being a successful contractor is also a successful farmer and cattle raiser. Smith had an auction sale of some Hereford bulls and cows at his farm at Pleasant Hill, Mo., on Friday, Sept. 28. From what we can learn he realized in the neighborhood of $150,000 on this sale. Auction sales of cattle will be a semi-yearly affair on the Smith farm in the future. The Smith Hereford's cleaned up all the big prizes at fairs in the Central States this fall. A. B. KOENIG.

Personals

F. M. Edwards has been appointed city engineer of Jacksonville, Fla.

Charles Schultz, who for the last three years has been city engineer of McKinney, Tex., has been given the additional duties of water works superintendent.

Major W. W. Crosby, formerly chief engineer of the State Roads Commission of Maryland, has been promoted to lieutenant-colonel of the 104th Regiment of Engineers.

H. Walter Leavitt has recently been appointed assistant professor of civil engineering at the University of Maine to succeed Prof. E. D. Kingman. Mr. Leavitt will also have charge of all the highway testing laboratories of the Maine State Highway Commission, which are located at the university. Mr. Leavitt was formerly student testing engineer at the Office of Public Roads, Washington, D. C.

A. L. Luedke has been appointed as assistant to the director of the U. S. Office of Public Roads and Rural Engineering, with headquarters at Washington, D. C. Previous to his appointment to this position Mr. Luedke served as engineer-economist to the office of public roads and installed the management and accounting systems for several of the newly organized highway commissions of the various States.

The following men from the staff of the El Paso Bridge & Iron Co., El Paso, Tex., have received commissions in the army: E. P. Rankin, Jr., captain engineers, Fort Leavenworth, Kan.; Henry E. Robertson, captain of infantry, Camp Travis, San Antonio, Tex.; L. L. White, captain artillery, Camp Travis, San Antonio, Tex.

Obituaries

William W. Marr, chief state highway engineer of Illinois, died Oct. 3 at his home in Chicago of Bright's disease. He had been ill since last June, but had continued at his work until three weeks before his death. Mr. Marr was 41 years old. He was graduated from Notre Dame University in 1895, and soon afterward became connected with the Chicago city engineer's office, and later was a division engineer with the board of local improvements. He was the engineer in charge of the work of paving the loop with creosote wood blocks. He was appointed chief engineer of the State Highway Commission by Governor Dunne and when the highway commission went out of commission on July 1 last Governor Lowden appointed him chief highway engineer.

Industrial Notes

The Macleod Co., of Cincinnati, O., in order to take care of its rapidly expanding business, has enlarged its plant and increased its capital to $100,000.

B. F. Devine has recently been made assistant advertising manager of the Chain Belt Co., Milwaukee, Wis. Mr. Devine is at the present time assistant manager of the mixer department and he will hold these two positions.

The Central Foundry Co. has secured an order from the government for approximately 2,500 tons of 4-in., 6-in. and 8-in. universal pipe and a large quantity of fittings.

T. H. Letson has opened an office at 50 Church street, New York City, where he will engage in the sale of hoisting and power machinery and contractors' equipment. A used machinery department also has been organized. Frederic Glanden, electrical and mechanical engineer, is associated with Mr. Letson. Mr. Letson for 17 years was New York sales manager for the American Hoist & Derrick Co.

John E. Woods, formerly manager of sales of the Carnegie Steel Co., Illinois Steel Co. and the Tennessee Coal, Iron & Railroad Co. at Cincinnati, O., has been appointed assistant general manager of sales in succession to John W. Dix, deceased, with offices in the Carnegie Bldg., Pittsburgh, Pa. The advertising and statistical work of the Carnegie Steel Co., however, has been separated from the sales work proper, and R. B. Woodworth has been appointed advertising manager and sales statistician.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

Of Engineering and Contracting, published weekly at Chicago, Ill., for October 1, 1917.

State of Illinois, County of Cook, ss.—Before me, a notary public in and for the State and county aforesaid, personally appeared the editor of the Engineering and Contracting and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Engineering and Contracting Publishing Co., Chicago, Ill.
Editor—Halbert P. Gillette, Chicago, Ill.
Managing Editor—C. T. Murray, Chicago, Ill.
Business Manager—Lewis S. Louer, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Halbert P. Gillette, Chicago, Ill.
Lewis S. Louer, Chicago, Ill.
N M. Clark, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more or total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is ——. (This information is required from daily publications only.)

(Signed) HALBERT P. GILLETTE, Editor.

Sworn to and subscribed before me this 26th day of September, 1917.

(Seal) C. E. MEINDERS.
(My commission expires June 7, 1920.)

Dirt Mover and Pit Owner Issue
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HALBERT P. GILLETTE, *President and Editor.*
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Volume XLVIII. CHICAGO, ILL., OCTOBER 17, 1917. Number 16.

ATTENTION!

American Engineers and Superintendents Wanted for Road Work in France

Civil engineers, contractors, superintendents and foremen who have had experience in highway work now have a chance to offer their services to their country. Road building battalions are being recruited and will form part of the 23d Regiment of Engineers. On the opposite page read the call for service in this battalion. Read it, and if your experience, age and health qualify you, consider seriously whether patriotism does not have precedence over any other duty or desire.

All of us hope and many of us believe that the world war will have ended before next summer, but preparation must be made to carry the conflict on for years if need be. Hence the thoroughness with which the American Government is equipping her fighting men and preparing to organize the men behind the men in the trenches. Of these men behind the lines none will render a greater and more important service than those who are to build and maintain the roads over which ammunition and subsistence will be carried to the front.

America manufactures a greater variety of road-building machinery than any other nation, and Americans know how to use it most efficiently even in times of peace. In war time we doubt not that a greater efficiency will be obtained, and that American road builders will not only do their important part well in France, but will teach the French and English themselves how to utilize labor to better advantage.

Remember, you American highway engineers, contractors and superintendents, that although Tresaguet the Frenchman, and MacAdam the Englishman, designed the earliest types of economic "hard roads," it was Blake the American who invented the rock crusher. Without a mechanical rock breaker, cheap stone roads and cheap concrete would not be attainable in any country where high wages prevailed. Rock drills operated by power were also first developed by Americans. J. J. Couch in 1850 made the first crude drill, and J. M. Fowle, a few years later, invented a drill which remained supreme as to type until recent years, and when other types of rock drill replaced the reciprocating type for certain work, they, too, were American inventors.

As for grading machinery, nearly every kind in general use for roadwork was first developed in America, excepting only the steam shovel. But even the steam shovel has been so greatly improved, and so many new types of it have been invented that America leads the world in the manufacture of shovels.

As suggested in the page facing this editorial, "A great opportunity is offered to demonstrate what skilled Americans can do with modern equipment." Who will respond to this call?

An Unusually Complete "Extra-Work" Clause

Editorial comment on the ambiguity of "extra work" clauses in specifications appeared in our last issue, accompanied with a brief discussion of what constitutes "actual cost" of force account work. In these days when "cost plus a fee" contracts are so prevalent, engineers and contractors may well devote an unusual amount of study not only to the general form and wording of specifications relating to "extra work" clauses and "cost plus" contracts but to the question of the amount of net remuneration that a contractor should receive as a percentage or fee.

Many western railways have been in the habit of paying a general contractor 3 to 5 per cent of the cost of construction work for acting as a general business manager. This relates to very large jobs, where nearly all the work is sublet, the general contractor himself having direct charge only of those parts of the work that it seems wise not to sublet or those jobs on which the subcontractors have "welched."

Extra work clauses usually specify that the contractor shall be paid "actual cost" plus 10 to 15 per cent for "overhead charges and profit," often including compensation for use of plant in the percentage paid. In such cases great care should be taken not only to specify what is included as "overhead charges" but to determine whether any real profit is likely to remain for the contractor after "overhead charges" are paid by him. We purpose discussing this matter at some length in future issues, incidentally quoting from recent specifications. One of the most complete "extra work" clauses that has come to our attention is found in the specifications for work about to be done (and now advertised in our proposal columns) by The Miami Conservancy District of the State of Ohio of which Arthur E. Morgan is Chief Engineer. We quote:

> **Extra Work.**—If, during the performance of this contract, it shall become necessary or desirable for the proper completion of the work hereunder to order additional work done or ma-

terials furnished, which in the opinion of the engineer are not susceptible of classification under the Schedule of Unit Prices, the contractor shall, if ordered in writing by the engineer, do and perform such work and furnish such materials; and he shall be paid therefor the actual and necessary net cost, as determined by the engineer, plus 15 per cent thereof. Such actual net cost shall cover all labor and materials necessary for the performance of the extra work, including any extraordinary expenses incurred directly on account thereof, the wages of foremen, and the expense attached to contractor's liability insurance covering the labor so employed; but in making payment to the contractor for such extra work, no allowance shall be made for overhead charges, general superintendence, general expenses, contingencies, or use and depreciation of, and wear and tear upon plant. Charge for extra work shall not include the maintenance of the contractor's camp, except in case such camp be maintained primarily to carry on extra work.

The contractor shall have no further claim in excess of the foregoing, and this method of payment shall not apply to the performance of any work or the furnishing of any material which in part or in whole is, in the opinion of the engineer, susceptible of classification under the Schedule of Unit Prices. In case any work or material shall be required to be done or furnished under the provisions of this section, the contractor shall at the end of each day during the progress thereof furnish to the engineer daily time slips showing the name or number of each workman employed thereon, with the time worked, the character of work he is doing and the wages paid or to be paid to him, and also a daily memorandum of the material used on such extra work, showing the amount and character of such material, from whom purchased, and the amount paid or to be paid therefor. If required by the engineer, the contractor shall produce any books, vouchers, records, and memoranda showing the work and materials actually paid for and the actual prices therefor. Such daily time slips and memoranda shall not be binding upon the district, except in so far as they are reasonable, accurate, and pertinent, and if any question or dispute should arise as to the correct cost of such extra work or material, the determination of the engineer upon such question shall be final and conclusive.

It is further agreed that if at any time the number of men employed by the contractor on work done under this section of the contract, or the character of such men or the plant and equipment so employed, are not, in the opinion of the engineer, the best adapted for the satisfactory prosecution of the work the engineer shall so notify the contractor in writing, whereupon the latter shall increase or decrease the number of men, or substitute different men, or make such changes in plant and equipment, as shall be ordered by the engineer. Extra work so ordered shall constitute a part of the work to be done under this contract, and all and singular the provisions and conditions of this contract and of the bond accompanying it shall apply to the said extra work as if the same were specified in the contract.

As a condition precedent to the right to receive any money for extra work and material furnished under this contract, the contractor shall deliver to the board, before the 15th day of the month following a month in which any such extra work has been done or extra material furnished, an itemized bill of the cost of such materials or work, and unless it is so filed the claim for an extra shall be deemed waived.

How to Keep Workmen on the Job

In the far west about the only class of laborers who "stay put" are the Mexicans. Is it because they are not given to "boozing"? Or are they naturally contented with whatever befalls them? Or is it because most of them are married and have their families with them on the job?

Those who have handled different classes of men in the west seem to agree that while Mexican laborers are not so restless in disposition as Americans and Europeans, this alone does not account for their inclination to stick to a job till the finish. The fact that the Mexicans are usually accompanied by their families accounts, in large measure, for their tendency to remain on the work.

May the day not be near at hand when the Mexican method, if it may be so called, will be generally adopted? May we not see construction camps in which a neat and comfortable house will be provided for each workman and his family? May not the extra cost of providing and moving the portable homes be offset by the greater efficiency of the working forces?

The following extract from a paper by F. B. Tapley, read before the Canadian Railway Club, is typical of many discussions among contractors and engineers as to steps that may be taken to eliminate the "hobo" or nomad laborer:

> I read the other day of the experience of a prominent American railway in doing some track elevation work in a large city. They hired 2,874 laborers in six months to keep a working force of 400 men filled up. In other words, they hired the men over seven times, and the average working time of each laborer amounted to a trifle over twenty-one days. In the same article, the experience of a firm of contractors doing public work adjacent to another large city, by force account, is given. The work consisted of ordinary hand work in rock, which is about as hard and unattractive as you could make it, yet very few changes in the working force took place, in spite of the fact that the rate of wages paid was, on the whole, considerably below the scale obtaining in the vicinity, and that labor agents from munition plants endeavored to entice the workmen away by the promise of higher wages. The reasons for the successful holding of the men on the job were quite simple. The contractor saw to it at the start that comfortable buildings were provided in which to house the men, and that a supply of good food, cooked and served in the way the different nationalities desired it, was on hand. These two influences were the main things that kept the men satisfied and on the job for a year, in spite of the efforts to get them away. Keeping the men on the job has the big advantage of a larger output of work per man, and a more efficient working gang. It is obvious to anyone familiar with the various features of [railway] maintenance work that the longer a gang works together and the fewer the changes made, that the work goes with a better swing and a higher class of work, and more of it will be turned out in a working day. The paper does not say what arrangement the railway had for housing and feeding their men, but you can make a pretty shrewd guess that they did not have as good accommodation as the contractor, or they would not have had to hire their men seven times over.

Digging Shallow Trenches with Plows and Scrapers

Where a pavement does not exist, where the trench is shallow, and where the amount of trench work is insufficient to warrant purchasing a trench machine, it frequently is more economic to dig a wide trench with plows and drag scrapers than to dig a narrow trench with picks and shovels. Even where the depth exceeds 3 ft., it often pays to dig the upper 3 ft. with scrapers and finish the lower part with shovels.

A two-horse plow will loosen as much ordinary earth as 15 or 20 men will pick, and a drag scraper will dig more dirt than 6 or 8 men will shovel. Hence doubling the width of the trench, to permit the use of a scraper, still leaves the scraper method cheaper than the shovel method, to say nothing of the ability to make good progress even when laborers are scarce.

Effect of Inadequate Ventilation on Tunneling Progress

An interesting example of the effect of poor ventilation on the efficiency of men engaged in underground work was cited by Dr. A. J. Lanza of the Bureau of Mines in a paper presented at the recent meeting of the National Safety Council. A mine, driving a long drift about 3,000 ft. below the surface, was paying $15 per foot, day's pay. The place was hot and moist. A small blower fan was installed at the entrance to the drift, with a canvas pipe leading nearly to the working face, and without any other change the cost was reduced to $8 per foot, day's pay. In shaft sinking this mine had made 50 ft. in one month and 60 ft. in another. A small blower with canvas pipe was installed and the next month 120 ft. was the progress made.

Railroad Construction at Long Island Cantonment

One of the new Government cantonments for the national army is located on Long Island on the Long Island R. R., about 65 miles from New York City. Hasty construction of trackage facilities by the Long Island R. R. was required to enable it to handle promptly the construction materials and accessories for the construction of the camp buildings. The methods employed in carrying out the track work were described by Mr. Coleman King, Supervisor, Long Island R. R., in a paper presented Sept. 18 at the recent annual convention of the Roadmasters' and Maintenance of Way Association, from which the matter following is taken.

The layout finally adopted by the Government required the construction of about 11 miles of track, 3¼ of which were to take care of the contractor's material for the construction of the camp buildings and necessary accessories. The balance, 7¾ miles, were for the permanent layout, including a "Y" to facilitate the operation, a passenger yard, engine yard, freight yard, team yard, wood yard, coal trestle and large storehouse tracks. This required the assembling of 116,160 ft. of rail, 42 turnouts of various sizes complete and 29,000 ties together with all the other track fastenings.

At the time the Government order for the construction of this camp was finally made formal the amount of track material actually at the railroad's main storage point was negligible and it required thoroughly combing the entire road for the necessary material. After all material not in the track was finally picked up it was found that the amount was not sufficient, and a number of small sidetracks which had not been in use for some time, and which were not likely to be used in the very near future, were taken up.

All the new rail on hand, which unfortunately was a comparatively small amount, was laid in track so as to recover the old rail for this construction. It can be readily seen that in order to pick up this large amount of rail at least one-half dozen different weights and sections were represented and of course the rail which was most accessible was picked up first, and the future assembling done in order, which necessarily, therefore, required the use of a great number of compromise joints. Of course it was impossible to get them in time from the manufacturers, and accordingly the railroad blacksmiths were immediately put to work and commenced turning out home-made bars as fast as possible.

Practically all the rail used was lying alongside of main track which required the use of an engine and derrick for loading it; excepting only where ties together with small lots of rails were loaded at various points along the line, all the loading was done by hand. Two gangs of men with work train, consisting of foreman and 15 men in each gang were almost continuously employed at loading small lots of rail and ties and necessary fastenings.

The ties loaded were those in piles along sections intended for this year's renewals, only 50 per cent of the allotment having been installed owing to labor shortage. As far as the ties were concerned the railroad was most fortunate inasmuch as it had a great number of oak ties coming in from the South in box cars. The majority of these ties were unloaded at two central points easily accessible to the camp where they were unloaded from the various cars and inspected. Those ties were later reloaded onto gondolas or flat cars by work train as fast as required for the construction work. Prior to receiving those ties, however, it was necessary to load some of the renewal ties as previously mentioned.

The construction work started on June 28, first by laying of a siding parallel with the main track ¾ mile long to accommodate the unloading and release of cars of contractor's materials already in transit. The next work started was the laying of the 3¼ miles of contractor's material trackage, the main stem of which is 12,700 ft. long with its alignment through the camp grounds so laid out to have the tracks convenient to location of buildings to be constructed. The right of way was cleared by the contractor's men. Track was laid over the rough ground, no grading being done other than cribbing over short sags, in some instances over 8 per cent grades. The track was raised later reducing the gradient to 2½ or 3 per cent on these grades.

The railroad organization consisted of six small extra gangs with a daily average of 75 laborers, one team of horses, and one work train with car of rail ahead and two cars of ties next. Dollys were used to skid the rail ahead onto push cars. The team was used to distribute half the required ties ahead, the balance being unloaded from cars as movements ahead were made and put under to rear of train. The material trackage was laid, surfaced and completed on Aug. 7. At about the same time that the contractor's material tracks were started the grading for the permanent terminal trackage was started. This trackage was to handle the passenger and freight business of the camp with passenger and freight stations located about one mile from main track on the camp grounds and required permanent roadway construction. In the construction of this trackage of 7¾ miles, 20,000 yd. of grading material was handled to make the grade. This grading was handled by one steam shovel, two locomotive cranes, one A-frame derrick mounted on car, one spreader car, one engine and crew, 20 12-yd. dump cars, 2 grading foremen, and 43 laborers.

The locomotive cranes and A-frame derrick also were used in handling materials. The necessary right of way clearing for this trackage was done by railway company forces. A road roller was pressed into service as a stump puller. The laying of the track followed closely after the grading. The labor forces engaged at the right of way clearing, track construction, handling of materials and assisting carpenters on terminal building materials consisted of 6 extra gang foremen and 110 laborers.

Both the contractor's material tracks and permanent terminal yard trackage were ballasted with cinders. A total of 369 hopper car loads approximately 26,000 yd. were used, all hauled 60 miles from western terminal, 80 per cent of which was purchased from New York City industries and delivered to the railroad company's Long Island city dock on scows.

In order to properly handle the business at the camp in addition to the regular traffic on the portion of single track main line it was also necessary to increase the length of the passing sidings at several points. This necessitated about 7,400 ft. of additional track with the necessary rail-ties and track fastenings to build.

At the camp terminal was constructed a passenger station freight house, engine house, water tank, train and engine men's buildings with eating and sleeping quarters, etc. All the railroad company's forces with the exception of the carpenter gang who had temporary eating and sleeping quarters at the camp, were moved each day in coaches by work train to and from the Jamaica terminal, a distance of 54 miles one way.

Cost of Blasting at a Colorado Quarry

Many quarrymen are now using explosives containing less nitrogen than the straight or gelatine grades. In a blast at the quarry of the Colorado Portland Cement Co., at Portland, Colo., 61,000 tons of rock were broken down with Monobel No. 6 explosive at a cost of about 3½ cts. per ton. The quarry face is from 39 ft. to 49 ft. high. The stone consists of homogeneous layers of limestone varying in thickness from 6 to 28 ins. and separated by thin layers of shale also varying from nothing up to 6 or 8 ins. The stratification is flat and the quarry floor practically level. Holes were drilled with a Keystone cable drill, size O, driven with a 15 H.P., variable speed electric motor, using a 5⅝-in. diameter bit. Each hole was drilled 2 ft. below the quarry floor level.

The blast consisted of 44 holes, arranged in four rows. Holes were spaced 20 ft. apart and the first row, consisting of 15 holes, was set 20 ft. back from the face, with 18 ft. between the rear rows. From 265 to 425 lbs. of Monobel No. 6 were loaded per hole. Each hole was primed with two No. 7 Du Pont electric blasting caps. One set of detonators was connected in series and the other set in parallel and all fired by means of a 220-volt D. C. power current. Sand was used for tamping.

The charge of powder in the first row was figured for 2¼ cu. yd. of stone per pound. This was done in view of there not being any burden in front at the bottom from previous shot as steam shovel in the last cut through had cleaned up. Holes in the rear rows were loaded for 2 cu. yd. per pound of explosive. This was to obtain a better shattering effect from the rear rows, as experience has shown that in order to get desired fragmentation when two or more rows of holes are fired simultaneously, rear row holes must be more heavily loaded as they must contain sufficient powder to heave up and shatter the material rather than push it out.

The following summary gives in detail the cost of preparing and firing the whole blast:

Number of holes	44	
Spacing average	20 ft.	
Burden average	20.6 ft.	
Depth average	45 ft.	
Tons of rock broken	61,182	
Cubic yards	30,213	
Cost of drilling (labor)		$ 261.89
Cost of drilling (power)		24.00
Total cost of drilling		$ 285.89
Total feet of hole	2,094	
Cost per ft. of hole (drilling)		$ .1317
Cost per ton of rock (drilling)		.0064
Charge of powder per hole	265 lb. to 425 lb.	
Amount of Mon. powder in shot	14,850 lb.	
Amount of Giant powder in shot	100 lb.	
Cost of 44-42 ft. fuses at $0.1848		$ 8.13
Cost of 9-36 ft. fuses at $0.1632		1.47
Cost of 42-24 ft. fuses at $0.1200		5.04
Cost of Mon. at $0.125, including freight		1,826.25
Cost of Giant at $0.115, including freight		11.50
Cost of shot (powder and fuse)		1,852.39
Cost of shot (drilling and loading)		325.64
Total cost of shot		$2,178.03
Cost per ton of rock (powder and fuse)		$ .0302
Cost per ton of rock (drilling)		.0046
Cost per ton of rock (loading)		.0006
Total cost per ton of rock		$ .0354
Number ft. of powder in all holes	1,294	
Number pounds of powder in shot	14,850	
Number of pounds of powder per ft. of hole from 5⅝" bit	12.25	
Amount of rock broken per pound of powder: 4.0 tons, or 2.03 yds.		

A New Leyner Machine for Punching Out the Bits and Shanks of Hollow Drill Steel

In rock drilling operations with the hammer drill, using hollow drill steel and air or water to expel the cuttings from the drill hole, there is considerable carelessness in the matter of keeping the hole in the drill steel properly opened. Plugged steels, wholly or in part, prevent proper functioning of the drill, drilling speed is retarded, water tubes are bent or broken and time is lost tinkering or, as often happens the drilling gang is idle while some one makes a trip to the shop after another drill steel or water tube.

To relieve this condition, the Ingersoll-Rand Co. has developed and is placing on the market, as an auxiliary to the Leyner sharpener, a new device—the Leyner shank and bit punch.

This compact and simply constructed machine consists principally of a cast iron pedestal, at the top of which are bolted the clamping and punching cylinders and apparatus. The drill steel is clamped by two jaws brought together by the movement of a pinion, operated by the clamping cylinder through the medium of a rack on the extended piston rod. The heat treated steel punching pin is attached to the piston of a punch-operating cylinder, and in such manner that it may be readily removed should occasion require. The front head of the punch cylinder is provided with a clearance space around the punching pin so that on the extreme reverse stroke air is exhausted against the heated pin, effectually cooling it. The maximum stroke of the punch is 6 in. An adjustable stop for the drill steel is provided to regulate the distance to which it is desired to have the pin penetrate. The standard punching pin is 5/16 in. diameter for a distance of 2 in. from the end and ⅜ in. for the remainder.

Leyner Shank and Bit Punch.

The operation of the machine is controlled by a single lever moving in a T-slot. A downward movement clamps the steel and a further side movement operates the punch. The operation of the control lever locks the clamp jaws before the punch can be brought into action. In like manner the punching device must be in neutral position before the clamp jaws can be opened. This safety feature prevents action of the punch before the steel is firmly clamped and in perfect alignment.

All moving parts are protected from dirt, grit and damage by tight-fitting covers; likewise the operator is guarded from injury.

The Leyner shank and bit punch occupies a floor space 22x44 in. and weighs 400 lb. A planking support is the only foundation needed.

The Motor Truck and Trailer in Telephone Line Construction

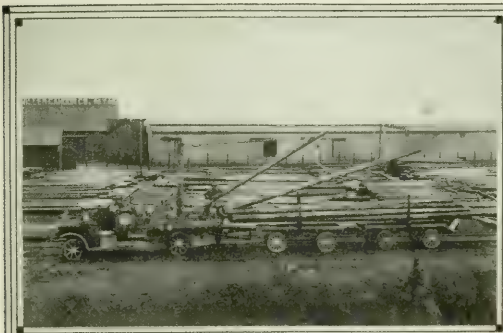


Fig 1—Loading 35 Ft. Poles with "Home Made" Derrick

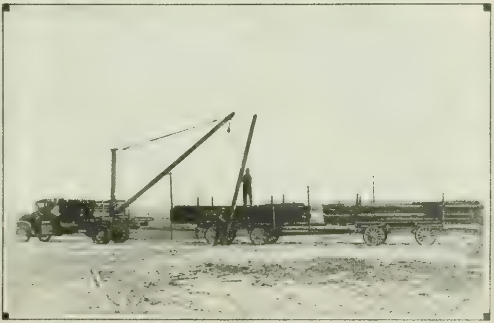


Fig 2—Showing How Poles are Taken from Trailer and Set by 2 Men

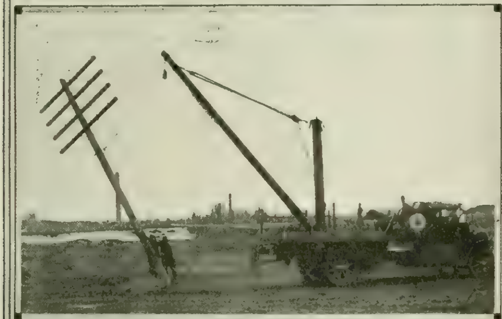


Fig. 3—New Method of Setting 35 Ft Poles

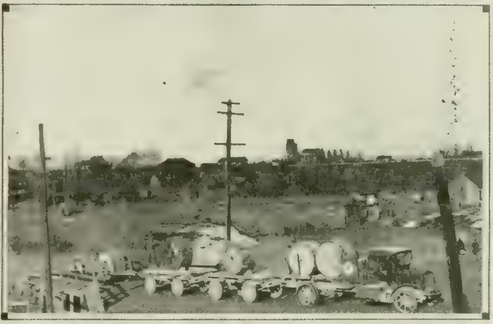


Fig 4—Hauling 24,000 Lbs of Cable

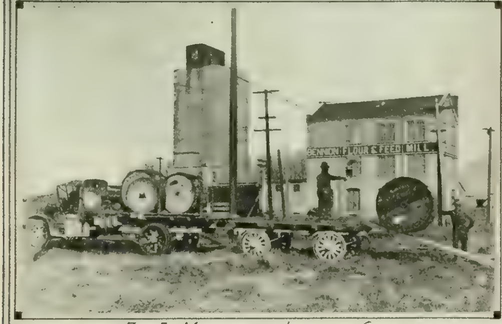


Fig 5—Method of Loading Cable

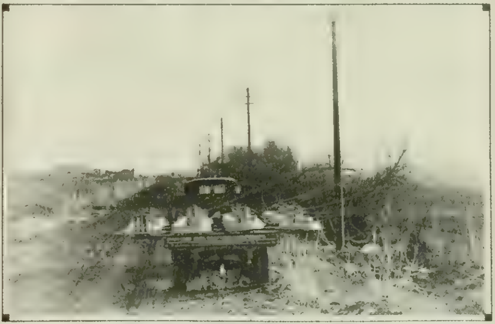


Fig. 6—Stringing 16 Wires at One Time

Motor trucks and trailers are being used extensively in telephone line construction by the Western Division of the Mountain States Telephone & Telegraph Co., of which Mr. E. F. Coyer is Division Construction Superintendent. Several interesting methods of handling the work with this equipment are illustrated above. The home-made derrick shown in the view, constructed mostly from telephone poles and mounted on a 3-ton White truck, has proved of great economy in handling material.

Figure 1 shows the derrick loading 35 ft. poles on 2½-ton Troy trailers. The device is operated by the winch from the truck and two men. This equipment replaces 4 teams and 10 men. A special bolster is used in the center of each trailer when hauling long poles. Fig. 2 shows the truck loaded with cross arms and the trailers loaded with 25-ft. poles. It also illustrates the method of taking poles from the trailers and setting by two men. This arrangement replaces 3 teams and 12 men. The new method of setting 30-ft. poles is shown in Fig. 3.

Figure 4 shows how lead-covered cable is hauled when long drives are necessary. The train consists of the 3-ton truck, two 2½-ton trailers and 2 two special 2-wheel trailers. The total weight of cable carried is 24,000 lb. This equipment replaces 3 teams and 12 men. The method of loading the cable with the truck winch and 2 men is shown in Fig. 5.

The method of stringing 16 wires at one time, which is somewhat unusual in the telephone business, is shown in Fig. 6.

Panoramic View of Camp Lewis, American Lake, Washington, Looking Across

$4,000,000 Construction Job Completed in 8 Weeks

The War Department's largest cantonment for the housing, care and training of the new national army of the United States, is located at American Lake, in the State of Washington. Built for the immediate occupancy of 48,000 troops, it was completed within 8 weeks after the construction chart had been finally approved by the Government authorities. The contractors established a record not only for speed, but one that is unique in other respects. The work was accomplished, to the complete satisfaction of the Government, without dispute of any kind between contractors and Government or local authorities, without labor trouble of any kind, except the inevitable shifting of personnel at pay-days; without accident of any serious kind to men or materials, and without sickness of any kind among the men employed.

The construction contract was awarded on June 14 to the Hurley-Mason Co. of Tacoma. The chart indicating the numbers of buildings of each type to be built was put in the hands of the contractors on July 2, was modified on July 5, and finally approved on July 10. Soldiers of the new army were to arrive on Sept. 5 and must be taken care of. Eight weeks were thus allowed for the work. And in that time it was done.

The cantonment is built in the general shape of a U, the size of which is indicated in the fact that the service railroad, running from one tip of the U around the base to the other tip, is 5 miles in length. Streets in the cantonment are laid out in orderly fashion and numbered, and each building carries its number and designation corresponding to its use. The buildings are of several different types, and include barracks for the soldiers, officers' quarters, mess houses, store houses, lavatories attached to each building, stables and sheds. The number of buildings and their use is indicated as followes:

Infantry	504	Ammunition Train	18
Division Headquarters	3	Supply Train	8
Brigade Headquarters	24	Engineers' Train	4
Field Artillery	246	Sanitary Train	24
Engineers	24	Heavy Artillery	228
Signal Corps	10	Telegraph and Signal	8
Headquarters' Train	8	Extra Buildings	28

These buildings, a total of 1,148, constituted the original plan; but to these have since been added the 58 buildings of the hospital group, and approximately 200 remount stables. The buildings are all constructed upon the standard Government plans, most of the larger ones being built on the unit system, by which the length may be increased by simply adding other units.

All the buildings are of frame construction. The barracks and officers' quarters have double floors with paper lining; the walls are ceiled on the inside, and covered with building paper and siding on the outside. Two-ply roofing paper is used throughout the construction. The windows are sliding, and doors and windows are all stock size. The warehouses, stables and other buildings of that kind are finished on the outside with one-ply roofing paper with battens. The hospital buildings are of a better class of construction and have wall-board partitions and ceilings, whereas the partitions in the other buildings are ceiled.

200-Men Barracks, Bath House, Lavatory and Warehouse in Process of Construction.

On a work of such magnitude, with everything to be completed and in readiness within so short a time, it was necessary to attack virtually every part of the undertaking at the same time. While the buildings were under construction, work was also in progress on the improvement of the site, road building, installation of the water system and sewer construction. The generally level character of the cantonment site made little grading necessary. Ten saw-mills established by the Hurley-Mason Co. just outside the "legs" of the U, turned all the lumber into proper dimensions, and this was delivered at the exact point of use by rail or auto truck.

Meanwhile work proceeded on the sewage and water systems. The water for the cantonment is taken from five springs, located west of American Lake. From these springs the water is pumped a distance of approximately 12,000 ft. through two 10-in. lines of wood stave pipe, to three 200,000-gal. wood tanks located on a hill, giving a head of about 125 ft. The

the Parade Grounds. Headquarters Are at Extreme Left of Picture.

water then flows by gravity through two independent lines of pipe, starting with 14-in., then 12, then 10, and so on, reducing in size. There are in use, approximately, the following lengths of each size of pipe:

	Feet.
14-inch	20,415
12-inch	10,000
10-inch	10,320
8-inch	2,600
6-inch	20,000
Small iron pipe	50,000
Total	113,335

Laying 24-In. Sewer at Camp Lewis.

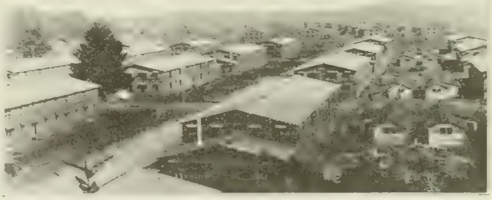
The sewer system, like the water system, is of permanent construction. The pipe ranged in size from 6 in. to 30 in. It was distributed as follows: 50,000 ft. of laterals on the south trunk; south trunk proper, 7,700 ft.; north trunk laterals, 44,384 ft.; north trunk proper, 8,452 ft. These two trunk lines empty into the outlet sewer, 15,725 ft. in length, crossing the highway and the main railroad line near the American Lake station, and thence crossing private property to a point on Puget Sound where it is carried to deep water, making a total of 126,261 ft., or 24 miles of sewers.

The contonment streets and buildings are lighted by electricity. Electric current is purchased from the Puget Sound Traction, Light & Power Co. and is distributed throughout the cantonment on government poles.

All of the barracks are heated by stoves; the officers' quarters are heated by individual steam plants, and the hospital buildings are all heated from one central steam plant.

The materials used in the construction of this cantonment have come from all parts of the United States. Inasmuch as the buildings are all of frame construction, the biggest single requirement in the way of material was lumber; and lumber being one of the biggest basic resources of the Pacific Northwest, the local product was used. The lumber for the cantonment was purchased through the Fir Emergency Committee in Tacoma, as were also the sash and doors, including glass. The Government made contracts in Washington, D. C., for much of the other material, and instructed the Hurley-Mason Co. to send in confirmatory orders. All of the cantonments were taken care of in this way, so that those nearest to sources of supply were not permitted to interfere with the supplies of those farther distant.

Except where the contracts were made at the National Capital, materials of all sorts for Camp Lewis were purchased as near to the work as it was possible to procure them. With so little time in which to complete construction, it was absolutely essential to get the materials on the ground without delay. This involved, first, getting the orders out immediately; secondly, placing the orders with those who were able to fill them at once; and finally, obtaining speedy delivery through the Hurley-Mason transportation department.



Looking Eastward Along North Leg of Barracks.

Labor for the construction of Camp Lewis was obtained, in the first place, from Tacoma, the nearest city. When that source was exhausted, the Hurley-Mason Co. reached into Seattle, Spokane, Portland, and even as far as San Francisco, to get the number of men necessary to complete the work on time. The work began with approximately 5,000 men employed, but the number was steadily increased until it reached a maximum of more than 10,000 men. Eight hours constituted the day's work, and the standard scale prevailing in Tacoma at the time the contract was awarded prevailed throughout the period of construction. The commissary department of the contractors fed and housed all the men who wished to live in the camp, and those who preferred to live in Tacoma, about 18 miles distant, went back and forth on special trains or by motor cars and auto trucks. Progress of the work was at no time disturbed or even threatened by labor troubles. Men quit from time to time for reasons of their own, and new men came to take their places; but the work swung through to completion without friction.

A very complete and effective system of organization was naturally required in order to carry on the big undertaking and turn the cantonment over to the Government, ready for occupancy, within the time allowed. The Hurley-Mason administration department dealt directly with the army administration, represented by Major David L. Stone, U. S. A., constructing quartermaster. The plans for all the work were furnished by the Government and the entire construction was under the charge of Major Stone. The contractors' administration department directed and controlled the activities of all other necessary departments, as auditing, quantity survey, building sewers, plumbing, heating, lighting, water and commissary, out from, and inter-related with which, were the labor bureau, information bureau, timekeepers, purchasing department, plant and plant transportation and repairs, stores and transportation, and bookkeeping.

Major Stone was assisted by specialists in their various lines. The sewer and water systems were under Engineer W. J. Roberts; buildings under Captain Louis M. Lang and Captain Charles H. Alden; electric light and power under Captain James S. Irvine, and the surveying under Captain Howard M. Smitten.

Service Rates for Cranes at Panama

The rates charged for the service of cranes and locomotives in the Canal Zone, according to a circular issued last month from the executive office of the Panama Canal are as follows:

	Per hour.
1. Locomotive cranes of less than 75 tons capacity, including engineer, fireman and the cost of coal, oil, waste and repairs:	
Between departments and divisions of the Panama Canal and the Panama Railroad	$2.75
For overtime service	3.25
To individuals and companies	3.50
For overtime service	4.25
2. Wrecking cranes of 75 tons capacity:	
Between departments and divisions of the Panama Canal and the Panama Railroad	3.75
For overtime service	4.50
To individuals and companies	5.00
For overtime service	6.00
3. Wrecking crane of 100 tons capacity:	
Between departments and divisions of the Panama Canal and the Panama Railroad	20.00
For overtime service	22.50
To individuals and companies, including overtime service	25.00
4. Locomotive service:	
To individuals and companies	12.00

Since April 21, when the Railroads War Board was created, the excess of unfilled car requisitions over idle cars (or what is commonly called car shortage) has been reduced 70 per cent. On April 30, the so-called car shortage amounted to 148,627. On June 30 these figures had been cut to 77,144. On Aug. 1 the excess of unfilled car requisitions over idle cars amounted to only 33,776.

The Sierra & San Francisco Power Co., of Oakdale, Cal., contemplates an expenditure of $5,000,000 for the construction of storage reservoirs, enlargement of ditches and the remodeling of flumes.

The Three 15 Cu. Yd. Dipper Dredges of the Isthmian Canal Commission and Cost Data on their Operation

In the early part of 1914 the Isthmian Canal Commission began operating two 15 cu. yd. dipper dredges on the completion of the channel through the Gaillard Cut of the Panama Canal. These dredges—the Gamboa and Paraiso—were built by the Bucyrus Co., the total cost including the towing to the Isthmus, being $573,287. The dredges operated so efficiently that the Commission placed another contract with the Bucyrus Co. for a third dredge, of improved design, the Cascadas. The dredge was placed at work in Gaillard Cut on Oct. 31, 1915, at a total cost of $376,180. An interesting study of the design, operation and efficiency of these dredges was given by Mr. Ray W. Berdeau in a paper* presented Sept. 19 before the American Society of Civil Engineers, from which the matter in this article is abstracted.

The following are the principal dimensions, etc., of the Gamboa and Paraiso:

Length of hull	144 ft. 0 in.
Beam, moulded	44 ft. 0 in.
Depth, moulded	13 ft. 6 in.
Draft	8 ft. 0 in.
Digging depth, below water line	50 ft. 0 in.
Displacement	1,730 tons

One main engine, two cylinders, compound, 16 by 28 by 24 in.
One swinging engine, two cylinders, compound, 12 by 16 in.
One backing engine, two cylinders, compound, 12 by 16 in.
Two forward spud engines, two cylinders, compound, 12 by 16 in.
One stern spud engine, two cylinders, 9 by 9 in.
Two deck winches, two cylinders, 6 by 6 in.
Two boilers, Scotch marine type, 126 in. diameter, 138 in. long, water pressure 150 lb.
Two forward spuds, 48 by 48 in., and 82 ft. long.
One stern spud, 30 by 30 in., and 83 ft. 6 in. long.
Swing circle, 24 ft. in diameter.
Bail pull, 235,000 lb.
Hoisting pull on spud rope due to engine, 88,000 lb.
"Pin up" pull on single cable, with brake on engine, 160,000 lb.
Capacity of rock dipper, 10 cu. yd.
Capacity of mud dipper, 15 cu. yd.
Capacity of fuel oil tanks, 14,200 gal.

The displacement of the Cascadas is 2,095 tons, and the hull is 144 ft. long, 55 ft. beam, and $15\frac{1}{2}$ ft. deep. Thus, it is 11 ft. wider than the others, making less reactions on the spuds, less metacentric variation when digging over the sides, and it allows the spuds to be inset. The spud-well construction differs from that of the Gamboa and Paraiso, as their forward spuds are placed outside of the hull, with tapering sponsons fore and aft to transmit the reactions to the sides of the hull.

Buckets.—The dredges were supplied with interchangeable buckets of two sizes, one with a capacity of 15 cu. yd. and another of 10 cu. yd., for use in rock excavation. Having been placed in Gaillard Cut in rock digging exclusively, the larger dippers have been seldom used; the smaller ones, as supplied by the contractors, were of extra massive construction, but were of insufficient strength to withstand the severe use and the impact from a dipper stick load of 131,000 lb., and were replaced later by the Missabe type of cast manganese-steel dippers. The over-all dimensions of the new dipper are $10\frac{1}{2}$ by 9 by 9 ft.; the lips are $3\frac{1}{4}$ in. thick at the bottom bands, and the body consists of a front and back casting with lap-riveted joints at the sides; and, in addition, the lip is a separate casting riveted to the front piece and joined thereto by the rivets of the tooth ribs. Recently, the back and bottom of this dipper has been further reinforced, and the dipper is expected to give greater service and satisfaction than the preceding models.

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*"The Three 15-Cu. Yd. Dipper Dredges, Gamboa, Paraiso and Cascadas, as Supplied and Used in the Panama Canal." Proceedings American Society of Civil Engineers. Vol. XLIII, pp. 963-976.

Cables.—The dippers are hung on a 275-ft., 3¼-in., extra pliable, improved, plow-steel wire, center cable consisting of six strands of 37 wires each, intended to withstand a bail pull of 235,000 lb., the minimum cable life being 3 days and the maximum 35 days. The rapid deterioration of the cables is due to the severe abrasion they receive while at their deeper digging depth (from 35 to 50 ft.), coupled with the deteriorating effects of their constant travel over an undersized point of boom sheave, which is grooved for a wire rope 3¼ in. in diameter and is about 8 ft. in diameter at the bottom of the groove. The sheaves are of cast steel, with long, heavy cast-steel hubs, bronze-bushed, to distribute the pressure over the 11-in. sheave pins, pressed into place; the cables, which are the largest in use on dipper-dredges, are hardly satisfactory for the service required, for which the supplying manufacturers refuse to guarantee them.

Dipper Handles.—The dipper handles on all the dredges are 72 ft. long, over all, and are reinforced top and bottom with 2x12-in. bars and by 1x22-in. plates on both sides of each dipper stick. Long-leaf yellow pine is used in the construction of the sticks, and white oak for dead wood. The racks are manganese-steel castings, with a pitch of 3 in., and are about 12 in. wide. They are shrouded to the pitch line, the top of the shrouded portion being ground to form a rolling surface for similar shrouding on the rack pinions. Heavy steel castings are used to connect the dipper hinge frame, and similar castings are used to connect the dipper back braces, which are securely bolted to the end of the handle by a large number of 2½-in. horizontal and vertical through bolts. The weight of the dipper handle is 81,000 lb., its life averaging about 6 months, that of the rebuilt handles being 3 months.

Saddle-Block.—The innovation in the design of the saddle-block has proved as useful as it is interesting. The slide plate is separated into two parts for assembling on the flanged shipper-shaft, leaving a passage in the middle, which permits the main hoist cable to run in a straight line from the foot to the point of the boom sheave. This eliminates the usual hump sheave, which is generally placed near the upper end of the boom and is necessary on other dredges to lift the single-hoist cable clear of the saddle-block.

The heavy unit construction facilitates the guiding and holding of the dipper handle in a much more secure manner, and improves the meshing of the racks on the dipper handles with the pinions of the 9½-in. hollow, nickel-chrome-steel, shipper-shaft, at times to such an extent that the teeth are stripped from them both. By building a heavier bucket, the dipper handle, saddle-block, shipper-shaft, and hoisting arrangement offer opportunity for improvement in design, in that the dipper stick would be stronger if it was made of one piece, two main hoisting cables being used, running on each side of the dipper handle, thereby increasing the life of the hoisting cable and also the dipper stick. This dipper stick at times becomes bowed, and, due to the sliding fit with the saddle-block, necessitates immediate re-alignment; this could be obviated if a rolling fit was presented, the rollers being supplied with bearings under compression. The shipper-shaft bearings, which are bolted to the top chord of the boom, project so that the flanges of the brake wheels, which are built of steel castings 75 in. in diameter with a 12-in. face and bolted to the flanges on each end of the shipper-shaft, engage the bearing boxes when lifted for removal, making an extended operation of changing the shippershaft. The brakes are of the double-acting type, and are actuated by a steam thrust-cylinder, the steam valve of which is controlled by a floating lever and operated by a hand-lever on the craneman's platform.

Booms.—The booms on these dredges are 62 ft. long, of the plate-girder type, with curved top and bottom chords. All parts of these booms are supposed to be of ample section to withstand developed stresses, which, due to the heavy type of work, have been such as to necessitate reinforcement of the different booms that, with complete machinery, weigh 113,000 lb. They are equipped with a steam-operated boom brake, steam shipper-shaft brakes, and a steam dipper-trip, the cylinder of which is mounted above the foot of the boom, and is connected with the latch bar on the dipper by an endless wire rope, the circuit beginning at the upper end of the dipper handle, leading around the sheave on the stand just below the shipper-shaft, and thence around the sheave attached to the cross-head of the steam dumping cylinder, which permits dumping in any position. The boom feet are of heavy steel castings, with webs and flanges of such length as to permit adequate riveting. The boom is stepped into a steel casting pivot, formed with sockets to receive the boom feet; the pivot rotates on a heavy cast-steel base plate, securely bolted to the hull, with its flanges extending over the front of the hull. The pintle is bronze-bushed, and has a bronze wearing plate or washer between the boom step collar and the base plate, and another bronze bushing and wearing plate is used between the base plate and the center casting of the swing circle.

Main Engines.—The main engines are specified to work at a steam pressure of 135 lb. while condensing. They are of the horizontal, twintandem, compound type, with 16 and 28-in. cylinders and 24-in. stroke, mounted on heavy self-contained cast-iron bed-plates of the Tangye pattern. The crank shaft is of forged steel, 12 in. in diameter, with journals 9¼ in. in diameter and 14 in. long, and with screw-adjusting bearings. The connecting rods, valve stems, and the adjustable bronze-shoed cross-heads are of steel, finished and arranged for taking up wear. The link motion and reverse gears are omitted on the Cascadas, and are replaced by a steam turning gear, comprising a steam reversing engine geared to the crank shaft with a releasing jaw clutch operated from the engine-room. The low-pressure cylinders have piston valves working in renewable cast-iron valve cages, a stuffing-box being incorporated between the high and low-pressure cylinders. The eccentric bearings of the Cascadas are larger than those of the Gamboa and Paraiso, and the Cascadas is equipped with an overhead 15-ton traveling crane.

Hoisting Drum and Gears.—The hoisting drum is of the differential type of cast steel, and is bushed with bronze. The small diameter is 69 in. and the large diameter is 84 in. at the bottom of the grooves, which are for 3¼-in. wire cable. The drum is mounted loose on the 16-in., forged-steel, main hoisting shaft, having journals 11¾ in. in diameter and 18 in. long. Power is applied to the drum by two outside, wood-lined, band frictions, one on each side of the drum, both operated by a single steam cylinder 14 in. in diameter, placed at one end of the drum shaft and attached to a thrust spindle passing through the center of the shaft. The drum is of the usual type supplied by the Bucyrus

Company on its dredges, and has a barrel-like shape, which permits the maximum digging force and the slowest speed when the dipper is excavating and the angle between the hoisting rope and the dipper handle is sharpest; as the rope is wound on the larger diameter, the dipper is hoisted, allowing any desired increase of hoisting speed when the maximum bail pull is not required. The diameter of the drum could be increased, which would reflect in length of cable life. The drum is driven by two heavy spur-gears, 12 ft. in diameter, one on each side, meshing with the corresponding pinion of the intermediate shaft. The gear hubs next to the bearings are lined with bronze. The intermediate shaft is driven from the crank shaft through a single gear, which has steel castings rim-bolted to a heavy cast-steel spider arranged for rim replacements without stripping the shaft. The intermediate gear rim is split for easy removal and replacements, and, like the pinion on the crank shaft, has cut teeth. The intermediate shaft is bolted directly on the engine bed-plates; the bed-plate also contains the drum-shaft bearings, and is of cast steel, forming an extension of the engine bed-plate, and is securely bolted to it and the structural base built into the hull.

Swinging Circle Machine and Guide-Sheaves.—The swinging circle is of structural steel, 24 ft. in diameter, and mounted on top of the hull truss; connection is made to the boom with two heavy built-up girders, extending out from the circle, one on each side of the boom. The center is a heavy steel casting, securely bolted to the circle, and has an I-beam rim reinforced with ½-in. plates, the jaws being fastened to the boom at the forward ends. Changes have been effected in the rope anchorage of the dredges by making the swing rope around the circle in four separate pieces with open socket connections, which renders complete stripping unnecessary when the rope is changed. Two 42-in. cast-steel sheaves, on top of the hull truss, grooved for a 2-in. rope, and complete with shaft bearings and 4⅜-in. sheave pins, are supplied for guiding the swing rope from the circle to the swinging drum. The swinging machinery is operated by an independent double engine, with 12-in. cylinders and 16-in. stroke, and reversing link gear. The engine and drum are mounted on heavy structural steel bases built into the hull, and the links are reversed by the steam thrust-cylinder controlled by the lever which operates the throttle.

Backing Engine.—The backing engine and drum are mounted on a structural steel base built into the hull, and the drum is operated by a separate 12 by 16-in., double, non-reversing engine. The cast-steel drum (26 in. pitch diameter) is driven by an outside-band friction clutch, actuated by a steam thrust-cylinder, 5 in. in diameter, and carries a 2-in. steel rope. The diameter of this drum is too small, as it breaks the strands of the cable, prevents proper reeling and causes slack on the drum, which prohibits uniform backing of the bucket. The gear reduction between the crank and the 7-in. drum shaft is single, and a band brake prevents the running out of the rope.

Forward Spud Machinery.—Each forward spud is operated by an independent, double, 12 by 16-in. engine, with link motion reverse, which is operated by a steam thrust-cylinder controlled by the lever which operates the throttle valve. The spud drums are 42 in. in diameter and are grooved for 2¼-in. wire rope. The Cascadas is "pinned up" and the spuds are lifted by a 2¼-in. wire rope passing around the four sheaves at the top of each spud; the pinning-up ropes are similar to those on the Gamboa and Paraiso, but the spud hoist ropes run over sheaves which are on a gantry

TABLE I.—MONTHLY PERFORMANCE OF DREDGE GAMBOA.

Date.	Cubic yards.	Cost of operation.	Cost of maintenance.	Total cost.	Cost per yard.
1914.					
April	32.805	$4,447	$10,798	$15,245	$0.4647
May	108,185	7,365	16,165	23,530	0.2175
June*	123,199	6,764	24,279	31,043	0.2519
July	108,896	7,441	21,148	28,589	0.2625
August	121,850	7,002	14,772	21,775	0.1787
September	111,355	6,561	12,238	18,799	0.1688
October	137,060	7,378	9,015	16,393	0.1205
November	140,905	7,612	8,902	16,553	0.1174
December	166,092	8,147	12,997	21,144	0.1274
1915.					
January	178,370	7,823	14,351	22,147	0.1244
February	149,554	6,308	8,939	15,247	0.1020
March	207,870	7,425	9,643	17,068	0.0821
April	168,725	7,003	10,593	17,596	0.1043
May	165,720	7,599	11,839	19,438	0.1173
June*	168,725	7,075	11,332	18,407	0.1091
July	171,370	7,376	9,421	16,797	0.0980
August	199,425	8,102	12.111	20,213	0.1014
September	280,570	8,263	8,455	16,719	0.0596
October	249,515	7,610	14,612	22,222	0.0891
November	260,845	8,280	10,431	18,711	0.0717
December	266,470	8,877	9,625	18,502	0.0694
1916.					
January	232,855	7,515	8,590	16,105	0.0692
February	293,230	9,103	10,056	19,159	0.0653
March	304,006	9,241	10,790	20,031	0.0695
April	263,275	8,896	10,460	19,356	0.0735
May	271,235	8,638	8,996	17,635	0.0650
June*	304,450	9,127	12,003	21,131	0.0694
July	320,190	9,448	9,055	18,503	0.0578
August	129,210	6,221	8,047	14,267	0.1108
September	150,175	7,749	8,238	15,987	0.1063

*End of fiscal year.

TABLE II.—MONTHLY PERFORMANCE OF DREDGE PARAISO.

Date.	Cubic yards.	Cost of operation.	Cost of maintenance.	Total cost.	Cost per yard.
1914.					
June*	69,812	$9,002	$11.458	$20,460	$0.2931
July	82,203	5,717	10,221	15,938	0.1939
August	95,475	6,729	20,155	26,884	0.2816
September	105,470	7,237	17,889	25,126	0.2382
October	125,605	7,380	9,644	17,024	0.1355
November	139,916	7,939	15,110	23,091	0.1650
December	144,165	7,824	12,371	20,195	0.1401
1915.					
January	176,862	8,111	11,381	19,492	0.1102
February	172,057	5.618	9,310	13,928	0.0868
March	134,030	6,395	8,740	15,135	0.1129
April	204,250	7,410	9,274	16,684	0.0817
May	184,510	7,240	10,889	18,129	0.0983
June*	174,685	7,880	8,856	16,766	0.0960
July	170,060	8,004	9,970	17,974	0.1057
August	203,815	8,064	10,748	18,812	0.0923
September	220,940	7,281	10,986	18,267	0.0827
October	291,675	8,859	15,502	22,361	0.0767
November	262,925	8,740	9,193	17,933	0.0682
December	312,920	9,716	10,154	19,870	0.0635
1916.					
January	195,515	7,296	8,587	15,883	0.0812
February	236,235	8,710	11,975	20,685	0.0876
March	299,155	9,099	11,324	20,423	0.0683
April	232,365	8,887	10,153	19,040	0.0819
May	306,435	8,649	10 871	19,520	0.0637
June	272,064	9,115	11.275	20,390	0.0749
July	233,930	6,418	7,192	13,610	0.0581
August	315,915	9 823	12.506	22,329	0.0711
September	268,250	8,921	9,029	17,950	0.0669

*End of fiscal year.

TABLE III.—MONTHLY PERFORMANCE OF DREDGE CASCADAS.

Date.	Cubic yards.	Cost of operation.	Cost of maintenance.	Total cost.	Cost per yard.
1915.					
October	695	$ 427	....	$ 427	$0.6145
November	296,280	9,372	$10,056	19,428	0.0656
December	321,065	9.961	10,221	20,182	0.0628
1916.					
January	292,675	9,055	10,769	19,824	0.0677
February	330,605	8,983	9,939	18,922	0.0573
March	309,125	8,796	10,723	19,519	0.0632
April	246,736	8.649	10,775	19,424	0.0787
May	316.770	8,848	10,818	19,666	0.0621
June*	286,491	9,172	9,995	19,166	0.0669
July	340,185	9,384	10,244	19,628	0.0577
August	203,967	8,135	9,481	17,616	0.0862
September	122,504	6,865	5,367	12,232	0.0987

*End of fiscal year.

TABLE IV.—YARDAGE EXCAVATED BY FISCAL YEARS.

	July 1, 1913, to July 1, 1914.		July 1, 1914, to July 1, 1915.	
	Cu. yds.	Cost per cu. yd.	Cu. yds.	Cost per cu. yd.
Gamboa	264,189	$0.3021	1,825,122	$0.1278
Paraiso	69,812	0.2931	1,739,228	0.1313
Cascadas	....	......	....	......

	July 1, 1915, to July 1, 1916.		July 1, 1916, to Oct. 1, 1916.	
	Cu. yds.	Cost per cu. yd.	Cu. yds.	Cost per cu. yd.
Gamboa	3,097,226	$0.0731	599,575	$0.0713
Paraiso	3,004,104	0.0769	818,095	0.0658
Cascadas	2,100.492	0.0651	666,656	0.0742

mounted near the spud casings and extending above the highest position of the spuds.

The Bucyrus Co. has developed a big improvement in this design, as it dispenses with the sheaves at the lower end of the spuds, where the wire ropes are quickly cut by the sharp stones found in the rock excavation in "the Cut." Wood-lined band-brakes, operated by a steam cylinder, are supplied to hold the dredge when "pinned-up," and the spud tackle rope is taken up by four parts of rope. Each spud engine is connected to its drum by double reduction gearing of cast steel; and a suitable friction clutch, operated by a steam thrust-cylinder, is provided to disconnect the drum from the engine, allowing the dredge to rise and fall with the tide when not in use. The spud drum machinery and engines are supported by a heavy structural steel frame built into, and set far enough from the side of, the hull to permit ready access to the spud machinery on the outboard side of the foundation. The sheaves guiding the spud ropes to the drum have a pitch diameter of 45 in., are cast steel, bushed with bronze, and have annealed, forged-steel, sheave pins. The stern spud machinery is arranged for a trailing spud that is hoisted by rack and pinion, through two gear reductions, by a 9 by 9-in., double engine, placed on and operated from the deck, at the stern of the dredge. The intermediate shaft is fitted with a band-brake, to hold the spud in its proper position, and carries a jaw clutch for disconnecting the drum from the shaft and the engine. The stern spud is of structural steel, 30 by 30 in. and 83 ft. 5 in. long, and is held in place by a sliding-fit arrangement somewhat similar to that of the saddle-block. This creates the necessity of immediate re-alignment when the spud becomes slightly bowed. The forward spuds are of structural steel, 48 by 48 in. and 72 ft. long, with 8 by 8 by ¾-in. corner angles, ¾-in. side plates, and suitable diaphragms, those of the Cascadas, as mentioned, having all sheaves at the top of the spud. As heavy as they are, these spuds have to be removed every 90 days, three being broken in as many days, in one case.

Operation.—All three dredges have been working until recently in Gaillard Cut of the Panama Canal. The material excavated consisted of hard and soft rock, to depth of from 35 to 47 ft. Tables I, II and III give the yardage of the respective dredges, Gamboa, Paraiso and Cascadas, and the material placed in scows alongside the dredges. The accompanying costs include operation, that is, wages of crew, subsistence of crew, fuel and lubricants, maintenance, that is, the cost of keeping the equipment in first-class physical condition, and depreciation only. Extra heavy 10-yd. manganese-steel dippers were used on this work, the dredges working continuously in three 8-hour shifts.

Size of Barge Canal Lock Chambers.—Exact measurements of the completed locks of the New York State barge canal have been made at each lock in order to determine the dimensions of these structures as they stand now. It has been found that the maximum rectangular parallelogram which can be passed through all the locks measures 300 ft. in length by 44.44 ft. in width. The upper end of each lock chamber is bounded by a wall which has a concaved lower face, these faces being circular arcs in some cases and made up of several chords in other cases. This concaved face adds 10 ft. to the length at the center of the lock chamber.

Labor Saving Equipment for Track Work on Illinois Central R.R.

As a matter of progress and to offset the growing scarcity of labor of all classes many American railways are now making extensive use of labor saving equipment for track work. At the recent annual convention of the Roadmasters and Maintenance of Way Association, Mr. E. J. Boland, Roadmaster of the Illinois Central R. R., presented a paper describing briefly the various labor saving devices employed on that railroad. The paper, practically in full, follows:

Each day shows more and more the labor scarcity, especially in the maintenance department, which employs a great number of unskilled laborers. These laborers are scattered in small gangs over a large territory which is more or less sparsely settled. The old-time home guard is passing away, which makes it necessary to import laborers of any and all nationalities, who must be properly placed. It is necessary then to provide comfortable living quarters for these laborers as an inducement for them to remain in this line of service. Work and boarding cars should be furnished in sufficient numbers and in such condition that laborers will be satisfied. This can be done by a number of methods, some of which are bunk cars with cook and kitchen cars, permanent laborers' houses and portable laborers' houses for more or less transient gangs, and last of all, tents. It is hard to estimate the saving or return which warrants this expense, but it is absolutely necessary that they be provided over the entire system to keep anything like an ordinary working force.

The steam ditcher is one of the greatest labor savers in operation today. The company now has nine ditchers of the boom type, seven of one and two of another make. The saving with the operation of each one of these machines is estimated at 10 ct. per yard on 250 cu. yd. per day over the next best method. Six months' operation per year will save about 50 per cent on the investment. If the work is heavy or if a sufficient number of machines is furnished, it is possible to work these ditchers in pairs; that is, two machines with one work train, making a further saving in expense of at least 5 ct. per yard. In addition to operating as ditchers, these machines can be used in loading and unloading rail, relaying rail, loading and unloading bridge timbers, loading ties, taking up abandoned tracks, transferring loads of timber, loading cinders, loading gravel ballast, excavating for scale pits, turntable pits and building foundations, excavating or building embankments for new sidings, loading heavy scrap, loading trucks and light wrecking.

Air dump cars in place of flat cars in ditcher service are of great value. The old method of handling dirt loaded by ditchers was to use a trian of 10 or 12 steel under-frame flat cars over which the ditcher operated by its own power, backing away as the cars were loaded. After loading, a Lidgerwood with plow and cable was necessary to unload the flats. In order to protect the ballast while unloading it is also necessary to equip the cars with aprons, which makes an additional expense. The present method is to operate two 20-yd. air dump cars with each ditcher, one ahead of the machine and one behind. By this method the cars are easily loaded and can be unloaded immediately. Mr. Boland's experience has been that a saving of 4 ct. per cubic yard can be made, based on 125 cu. yd. per day, which figures about 22 per cent on the investment, based on six months' operation per year. This also releases the 10 or 12 steel under-frame flat cars for revenue service and the Lidgerwood for heavier work in unloading gravel ballast.

The company now has 11 Lidgerwood unloaders. These machines are used on various parts of the system in unloading gravel ballast, sand for track elevation, dirt, strippings for banking and any similar heavy work which is found necessary. A trainload of gravel from the Foreston, Ill., pit consisting of 35 Haskell & Barker cars of about 30 yd. each can be unloaded with one of these machines in about 30 minutes, provided the material is unloaded continuously. This operation would require 210 men for about 2½ hours without this equipment. These machines, when operated six months of the year, will save at least 50 per cent on the investment.

The company has provided each roadmaster and track supervisor with an inspection car, which has increased the efficiency of these officers over 100 per cent. The track can be given much closer attention than by any other method. The entire district of 100 miles can be covered in two days without trouble, enabling these men to give close attention to the work and to confer with every foreman and road department employe en route.

There is no question about the economy of placing a motor car with every section, bridge and signal gang. Until recently the company had only a few sections so equipped with cars of company ownership. A great number of the men had realized the advantages that could be obtained from motor cars and had purchased engines themselves from various makers, which were installed on their hand cars. It was found after three or four years that almost every make of engine was being operated and instructions were issued that no more engines should be purchased by foremen to operate on the company lines. Last spring the road purchased a number of section cars and during the summer and fall of the present season an additional order was placed for a sufficient number of cars to equip all of the gangs mentioned. This order was divided between three companies. Arrangements were also made to purchase the engines from the foremen, so that the company would be the sole owner of all of the motor-car equipment on its lines. It is estimated that one hour can be saved for each gang each day by a motor car. The men are also fresh on arriving at their work and do not dread the homeward trip at the close of the day's work. The additional advantage obtained in this class of work is that the gangs often travel long distances. The men are carried to their work with the greatest dispatch and are not worn out by the trip. It is not necessary to move the camp outfits nearly so often, which saves car mileage and switching. It is much easier to obtain labor and the men are much better satisfied.

After trying out a motor car mowing machine for two years it was found so desirable that 13 more were purchased, one for each division on the system. These cars will mow a neat swath on each side of the track at the rate of about 30 miles per day. Each machine will save its cost every year.

The nine tracklaying machines which are now operated by the company have been of great service in offsetting the labor situation. They are a great relief to the men, as the machine does all of the heavy lifting. The gangs can be reduced or more rail laid than was possible with the same gang prior to operating the machine. The ordinary new rail program on this road includes between 50,000 and 60,000 tons per year and any reduction in the cost of laying this rail cuts down one of the largest items of expense.

Each division is now equipped with an approved air rail loader which can be operated with three or four men, whereas this work formerly required about 20. A saving of this kind is an absolute elimination of all of the useless work which was formerly done by hand. A modern railroad cannot afford, in the present day, to handle rail without a device of this character.

Tool grinders have come into the maintenance of way world to stay. In taking the place of the old grindstone, it relieved about the most cumbersome tool that was carried on the hand or motor car. Grinders cost from $12 to $25, depending on the number of attachments provided with the machine. Tools can be kept in better shape and the machine saves its first cost in one season.

Weed burners are of great value in the heavy semitropical country, such as the Yazoo delta and the sugar cane territory near New Orleans. The growth is so rank in this territory that it is almost impossible to handle it by the ordinary hand method. These machines, when operated over a district a second time, destroy all growth for a width of 18 ft. for an entire season. The labor of operating is almost nothing, compared with hand work in the same locality.

The company is now operating one portable rail saw at Clinton, Ill., and authority has been granted for an elaborate permanent sawing plant to be located at Centralia. All second-hand No. 1 rail of the 85-lb. and 90-lb. class is sawed and re-drilled before relaying in branch-line main track. The sawing process makes infinitely better riding track and adds greatly to the life of second-hand rail. It is figured that about $2 per ton will take care of all of the expense of handling and sawing. The riding of track has improved 100 per cent by using sawed rail, in comparison with the old method. The results accomplished have been well worth the expense.

Snow thawing outfits are almost a necessity in large terminals. The greatest advantage in these outfits is that it is not necessary to reload snow and ice taken from switches and interlocking plants. In congested territory it was formerly necessary to cast snow out of the switches and in some cases it would have to be handled five or six times before it was finally disposed of. Snow thawers give immediate relief and do away with the re-handling. One man with one of these outfits can accomplish as much as three or four by the old method.

Each terminal should have a sufficient number of cinder cars to take care of all of the cinders handled without using cars in revenue service. Cinders are now loaded at large terminals with some approved form of clam shell, but it still remains for the section men to unload the cinders out on the line. The side dump car with the ridge bottom is the best class of car in service. It is proposed, however, to make these cars large enough to hold 50 tons of cinders, which would cut down the number of cars and greatly aid in the distribution. Ordinarily the Illinois Central cinder cars have been made from old condemned coal cars and were of very light capacity. It is almost impossible to estimate the amount of money lost in the maintenance department on account of using coal cars, especially during freezing weather and the rush of business when cinder cars are not available.

There are many other small devices which are of great advantage to the trackman, some of which are:

Lawn mowers,
Switch-point straighteners,
Portable electric timber drills,
Oxweld repair outfits,
Ballast screening outfits,
Rail benders,
Snow plows and flangers,
Electric trucks (for service in shipyards and docks),
Cleaners for bridge steel,
Tie sizing and boring machines,
Acid grass and weed killers.

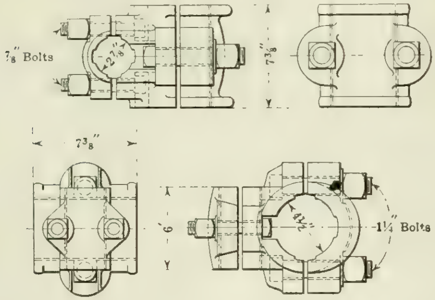
To sum up the matter, the company has purchased during the last year—

4 new boom-type ditchers,
2 air dump cars to go with each ditcher in service,
1 new Lidgerwood unloader,
2 new left-hand dirt plows,
4 tracklaying machines,
5 American rail loaders,
2 rail curvers,
14 supervisors' inspection cars,
1 portable rail saw,
1 permanent rail saw,
16 25-ton ball-bearing jacks,
1 weed burner,
13 motor-car mowing machines.

in addition to equipment already in service. During the next six months all section, bridge, extra gang and signal gangs will be equipped with motor cars.

Special Column Clamp for Hammer Drill

A special type of column clamp is used in the hard-ground drilling at the mines of the New Jersey Zinc Co., at Franklin, N. J. Hammer drills of the water Leyner type, such as the Sullivan D. R. 6, the Ingersoll-Rand 18A and the Waugh Dreadnaught are employed. These are mounted on shells. By means of the special column clamp an arm made of 2½-in. extra heavy pipe is used with a column made of 4-in. extra heavy pipe. In addition, the length of this arm on either side of the column can be changed at will, for the clamp is so constructed that the pipe arm is set at a tangent to the column, instead of on a radial line. This pipe fits in the clamp, the same way the column does, and can be moved in the clamp, just as the clamp can be moved up or down on the column. The construction of this clamp is shown in the sketch and the same kind of clamp is used with the lighter machines, but both the column and arm are the same size, 2½-in. extra heavy pipe of 2⅞ in. outside diameter. However, the 4-in. column is preferable when double jack screws are used as a man may readily distort the lighter columns by failing to equalize the force exerted by each of the jack screws.



Special Column Arm Clamp.

A 3,000,000-cu. yd. drainage job is being advertised for bids by the Grand River Drainage District of Bates and Cass Counties, Missouri. The work includes the construction of 24 miles of main ditch.

An Improved Method of Taking Cross Sections for Jetty Construction

In rebuilding the jetties at the entrance to Humboldt Bay, California, it was necessary to follow carefully the submerged enrockment of the old jetty, so as to provide a substantial berm of stone at toe of slope. In order to do this with the best alignment, it was necessary to take cross-sections regularly ahead as far as practicable, and to furnish cross-sections of completed embankment, at every 100-ft. station, at least. These cross sections were made at first by use of row boats and tag line—the usual method—but this plan, owing principally to sea conditions, proved uncertain, slow and expensive. Accordingly a method of taking cross sections by utilizing the crane employed for placing stone in the jetty was developed. This method is described by Mr. George F. Whittemore, Assistant Engineer, in the September-October Professional Memoirs, from which the matter following is abstracted.

The crane is a revolving, self-propelling crane of 700 foot-tons capacity, using from 35 to 50 ft. radius of boom. For taking cross-sections the boom of crane is made to support horizontally a very light wooden "outrigger" platform, which is suspended by means of old ⅝-in. diameter wire ropes in the manner shown in Fig. 1. The horizontal "sway-guys" are made of one strand each from a six-strand ⅝-in. diameter plough-steel cable.

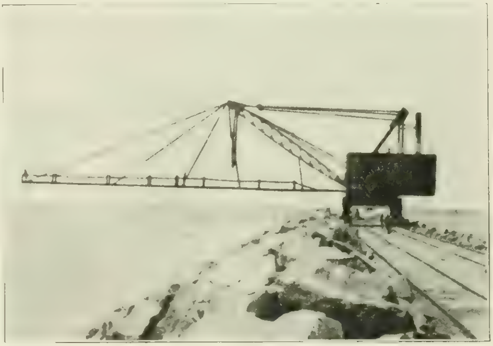


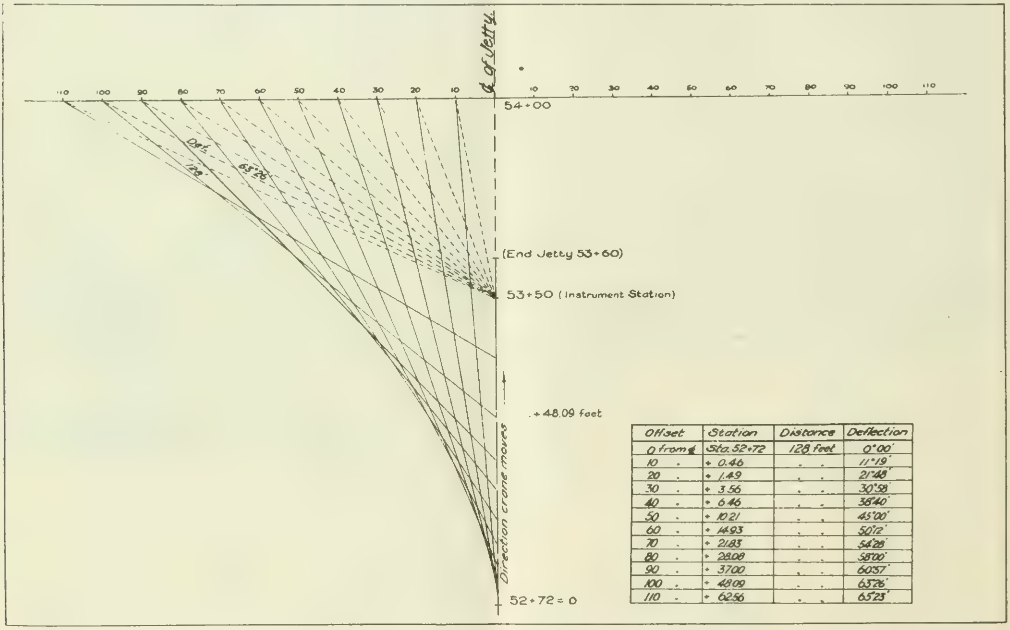
Fig. 1—Wooden Outrigger Platform Supported by Boom of Crane.

This platform reaches out 128 ft. from center of crane, and is itself 120 ft. in length. Measuring from the center of crane, which coincides with the crane tracks and concrete cap, the platform is marked in 10-ft. stations. The height of platform is constant above jetty cap, which is built level transversely, and generally level in profile.

This outfit was first used, during June, 1915, to take cross-sections of the south jetty, then just completed. The lumber used in its construction is of No. 2 common Oregon pine, as follows: 3x4-in. sills, which are scarfed and bolted to form two through stringers laid about 24 in. apart; upon these are nailed transversely 1x3-in. battens, over which are placed 1x8-in. boards laid horizontally for a walk; and posts of 2 in. x 4 in. x 3.1 ft. spaced about 15 ft. apart on either side of the walk, through the top of which are ¾-in. diameter manila ropes, drawn taut, to serve as hand-rails. To prevent swaying, a piece of timber 6 in. x 10 in. x 46 ft. is used as a horizontal brace and attached to stem of platform, to which it is fastened at right angles, and, when the "outrigger" is to be used, is made fast by bolts through this brace to the front of upper body of crane. To this timber brace several horizontal wire guys are fastened taut to various points on the stringers or sills of platform.

A profile of cap of jetty is accurately kept, and cross-sections are taken of completed structure from time to time, at the required stations. The elevations of these cross-sections are taken with a lead-line measuring from the floor of platform to enrockment above and below water. The distances on the platform from the center-line of concrete cap, or crane-way, are marked 10 ft. apart.

The platform, when attached for service, is tested as to its uniform elevation, before and after using, by turning it over a level stretch of cap; or, if more convenient, by use of vertical offset from height of instrument. Occasionally there is a slight ascending grade seaward to which the platform is adjusted by level, so as to swing the required arc with a minimum variation from the horizontal plane, which variation would be of no practical value when applied to this class of cross-section.



Offset	Station	Distance	Deflection
0 from ℄	Sta. 52+72	128 feet	0°00'
10 .	+ 0.46	. .	11°19'
20 .	+ 1.49	. .	21°48'
30 .	+ 3.56	. .	30°58'
40 .	+ 6.46	. .	38°40'
50 .	+ 10.21	. .	45°00'
60 .	+ 14.93	. .	50°12'
70 .	+ 21.83	. .	54°28'
80 .	+ 28.08	. .	58°00'
90 .	+ 37.00	. .	60°57'
100 .	+ 48.09	. .	63°26'
110 .	+ 62.56	. .	65°23'

Fig. 2—Method of Sounding with Crane and Outrigger.

To facilitate correct and ready adjustment to its proper horizontal position, the platform, when not in use, rests upon a "grid-iron" which has been erected level at the correct horizontal and vertical distances from the crane tracks at their shore end, which tracks are level in profile and cross-section at this particular place.

Sometimes the outrigger is slightly out of level, due to stretching here and there of supporting cables, which data are noted. In plotting the sections thus taken, the center height of sounding platform is plotted first and platform, with its varying elevations, drawn thereon, using a template of bristol-board, quickly cut out to correct scale and form, from which line the vertical offsets to jetty and bottom below are readily plotted by means of a short scale. One-half foot has been the maximum variation of outrigger from a horizontal plane, which error is readily corrected by adjustment of the vertical guys, before using the "platform" another time.

For locating the submerged old jetty enrockment ahead of construction, and for taking borings through the sand blanket over the old stone, this outfit is especially suited.

The cross-sections are taken as shown in Fig. 2. The positions of end of patform (where the leadsman is stationed) and center of crane, for each sounding 10 ft. apart, for cross-sections taken ahead of jetty construction. are shown in the sketch. The end of platform is placed by means of deflections turned by transit from a fixed station near end of jetty when the seas are not too heavy; or by an improvised "horizontal circle" painted on lower body of crane where the "graduations" are visible from the platform above, for use in stormy weather. The corresponding position of crane, for each sounding, is marked with paint on the cap below. Cross-sections of finished structure are taken by placing the platform, full length, over the section to be taken.

The crest of the old enrockment, to its end, is indicated by buoys made in the most substantial manner. These are located by instruments and plotted on a large-scale working map. As the jetty is extended, its location is plotted and compared with the alignment of crest of old enrockment as revealed by the cross-section just taken and positions of the buoys ahead. This procedure is necessary to prevent unnecessary changes and to make the best general alignment.

Ordinary cross-sections, 250 ft. wide, with not less than 24 soundings, have been taken, using a 14-lb. lead in rough "weather," in 45 minutes. To attach and adjust the outrigger for service, 20 minutes time is sufficient; and about the same time is necessary to take off and to store the platform on its rack or "gridiron."

The crane travels at a rate of 2 miles per hour, and therefore can make the round-trip from gridiron to jetty end in 50 minutes, if there are no obstructions.

When taking cross-sections ahead of construction, with this outfit, the following are used: 1 craneman, to operate crane, at $4.50 per diem; 1 fireman, on crane, at $2.50; 1 leadsman, on platform, at $3; 1 recorder, on platform, at $77.50 per month; and 1 transitman, on cap, at $83.33; total crew, 5 men.

About eight cross-sections are taken in one "shift" of 8 hours in ordinary weather, and the cost thereof for labor is about $2 the section.

The "gridiron," used for storing this platform, is 120 ft. long, or about the length of outrigger itself. The component parts of this gridiron are as follows: Height from ground to top of rollers, 11 ft. (average); 7 bents with 2 posts, each 4x8 in., and set firmly in sand about 5 ft. apart; caps 4x8 in. and with each bent sway braced with 2x6-in. boards, and well braced, longitudinally. On the cap of each bent is placed a 2-in. diameter pipe roller, 30 in. long, with wooden core. Upon these rollers the platform, when detached, is moved by hand to clear the tracks or back again to upper frame of crane, as needed.

The total cost of the outfit, complete, was: For gridiron, $75.10; for outrigger, $55.61; total, $130.71.

Specifications for Watertight Embankments Made by Three Different Processes

Contractors and hydraulic engineers will be interested in the earth work specifications drawn by Arthur E. Morgan, Chief Engineer of the Miami Conservancy District, Dayton, Ohio, for the dams for the retarding reservoirs of the flood prevention project of this district, for the construction of which bids are to be opened on Nov. 15. These dams will require about 1,825,000 cu. yds. of excavation, 7,850,000 cu. yds. of embankment, and 197,000 cu. yds. of concrete. Three alternatives are provided for constructing the embankment: (1) A hydraulic monitor or dredge pump method, (2) A semi-hydraulic method, and (3) A sprinkling and rolling method. The specifications for these three methods follow:

Embankment—Class A.—The term Class A Embankment shall be used to include embankment for main dams, constructed by Hydraulic Monitor and Dredge Pump Method: This method consists of washing down or otherwise delivering material to a dredge pump, which in turn delivers it under pressure through a discharge pipe onto the embankment. In washing down materials, properly constructed nozzles shall be used, with a sufficient flow of water, both as to velocity and quantity, to loosen the materials at the borrow pits, and sufficient additional water to insure the transportation from borrow pits to sump. The dredge pumps, pipes, flumes, sluices, and other transporting equipment shall be carefully installed to meet all requirements for the proper placing of the materials in the embankment.

The outer slopes of the dam shall be carried up in advance of the central position. The width of these outer levees, and the depth and width of the settling pond, will largely control the gradation of materials, and shall be subject at all times to the direction of the engineer. Care should be taken to place in the outer levees material which will conform to the requirements for the outer portion of the dam, and to satisfactorily compact such material. The material for the main body of the embankment shall be delivered near the outer edge of the embankment slopes, and so manipulated that the coarser material will remain near the outer slopes, and the finer materials will be carried toward the center, the finer materials being deposited in a settling pond so as to form an impervious core. It is of the utmost importance to avoid stratification within this core. The delivery and manipulation of the materials shall be regulated so as to obtain the best distribution of material, and to keep the water surface of the settling pond as nearly uniform in width as possible. The bottom of settling ponds shall be kept approximately level longitudinally to prevent undue flow of silt to one end.

Sluicing operations shall be conducted at all times in such a manner as to give a puddled core of as uniform width and slopes as the nature of the material used will permit, and to raise both sides of the embankment evenly. Embankment operations shall, unless otherwise permitted in writing, be commenced in the deeper portion at the river section or at the stream control gap, and shall be carried as nearly level longitudinally as possible. Should the use of a series of settling ponds be permitted, they shall be of convenient lengths, separated by temporary cross dams of sufficient thickness to withstand the pressure against them, built of selected material and puddled by hand, or by some equally efficient method, to the satisfaction of the engineer. As the sluiced material is washed against the temporary cross dam and raised in the embankment, the stratification between it and the cross dam shall be broken by the use of shovels or other suitable tools.

Drainage of surplus water from a higher to a lower settling pond may be permitted if suitable means for such drainage is provided. Whenever the waste water carries silt from one settling pond to another, the outlet shall be immediately raised or sluicing operations in that pond discontinued until such time as this condition has been remedied. The contractor shall take care of all excess water in the settling pools by means of wells, built up in sections, discharging at approved points, or by pumping, siphoning, or other approved methods. Such devices shall provide for the removal, at the desired elevation, of the comparatively clean water at the surface of the settling pool, while affording ample opportunity for the finer particles to settle properly. Before the completion of all the work, any outflow device within the dam shall be satisfactorily filled with concrete or other acceptable material unless otherwise ordered. No outflow device which will remain within the dam shall be installed until written permission for such installation has been obtained from the engineer; and such permission will not be given until evidence satisfactory to the engineer has been presented to show that adequate provisions can and will be made for completely and satisfactorily filling such device wherever necessary, before the completion of the work. The cost of all labor and all materials required under the provisions in this section shall be included in the price stipulated in the agreement.

Variations of this method during construction, which will accomplish equally effective results, will be considered.

Embankment—Class B.—The term Class B Embankment shall be used to include embankment for main dams, constructed by the Semi-Hydraulic Method, as follows: The material shall be obtained from borrow pits, or from excavations, transported in cars or by other suitable means, dumped at the outer edge of the embankment slopes, and sluiced toward the center of the dam. In depositing the material in the dam, care shall be taken where necessary, to place the coarser material in the downstream portion of the dam and the finer material in the upstream portion. The sluicing shall be carried on in such a manner that the coarser material will remain near the outer slopes of the embankment, and the finer material will be carried toward the center, the finest material being deposited in a settling pond so as to form an impervious core. It is of the utmost importance to avoid stratification within this core. The quantity and pressure of water, and the direction and point of application of the stream, shall be regulated according to the nature of the material so as to obtain the best distribution of material, and to keep the water surface of the settling pond as nearly uniform in width as possible. The material of the upstream slope shall not be washed clean, as it is desired to have a certain percentage of clay and sand retained near the upstream slope. The bottoms of settling ponds shall be kept approximately level longitudinally to prevent undue flow of silt to one end.

Sluicing shall be done at all times in such a manner as to give a puddled core of as uniform width and slopes as the nature of the material used will permit, and to raise both sides of the embankment evenly, and the quantity or direction of the sluicing stream shall be changed as required to obtain this result. The material shall be so placed on the slopes and sluiced or puddled in such a manner that it will be compacted by water as close as practicable to the outer edge of the finished slopes. Embankment operations shall, unless otherwise permitted in writing, be commenced in the deeper portion at the river section, or at the stream control gap, and shall be carried as nearly level longitudinally as possible. Should the use of a series of settling ponds be permitted, they shall be of convenient lengths, separated by temporary cross dams of sufficient thickness to withstand the pressure against them, built of selected material and puddled by hand, or by some equally efficient method, to the satisfaction of the engineer. As the sluiced material is washed against the temporary cross dam and raised in the embankment, the stratification between it and the cross dam shall be broken by the use of shovels or other suitable tools. The contractor shall take care of all excess water in a satisfactory manner.

The cost of all labor and materials required under the provisions of this section shall be included in the price stipulated in the agreement.

Embankment—Class C.—The term Class C embankment shall be used to include embankment for main dams, constructed by the Sprinkling and Rolling Method, as follows: The embankment shall be built as nearly as possible in horizontal layers, each layer not exceeding 6 inches in thickness when acceptably compacted. Unless the earth is sufficiently moist when spread, each layer shall be wet so as to secure the desired compacting, and if required, the top of the embankment shall be wet just before a layer of earth is spread. The wetting shall be done in a manner which will avoid the formation of pools of water, and will secure the uniform moistening of all portions of embankment. Compacting shall be accomplished by not less than 12-ton, 3-wheeled steam rollers, or traction engines, with grooved, banded, or corrugated rolls. The roller shall pass over every part of each layer that can be traversed by the roller, as many times as may be necessary to thoroughly compact it. The distributing, wetting, and rolling shall be done to the satisfaction of the engineer. Any places that become boggy or springy shall be corrected to the satisfaction of the engineer, or as much material as necessary shall be removed and the hole refilled in a satisfactory manner. Embankment operations shall, unless otherwise permitted in writing, be commenced in the deeper portion at the river section or at the stream control gap. Unless otherwise permitted in writing, the embankment shall be carried up approximately level, and in any case the top of unfinished embankment shall not have a slope steeper than 10 to 1 in any direction. Portions of the embankment which are small in area, portions next to walls, and other portions which the rollers cannot reach for any reason, shall be formed of selected materials compacted by means of extra heavy tampers used energetically, or if permitted, by depositing the earth through water in such a manner that all of it shall be thoroughly saturated, or by other means which will secure a degree of compacting at least equivalent to that obtained by rolling as specified. All stones over 4 inches in diameter shall be removed from the portion of the embankment required to be water tight. Stones permitted to remain shall be separated one from another by earth, and in no case shall they be allowed to collect in nests. Stones and cobbles removed from the impervious portions of the embankment shall be placed on the slopes in the manner and to the extent directed. The cost of all labor and materials required under the provisions of this section shall be included in the price stipulated in the agreement.

Embankment—Class D.—The term Class D embankment shall be used to include embankments for levees built from material taken from river channel excavation and constructed as follows:

The embankment shall be carried up in approximately horizontal layers, extending entirely through the fill. Where the material is deposited in a wet condition, the layers shall be not more than 3 feet in thickness, but where the material is deposited in other than a wet condition the layers shall not exceed 1 foot in thickness, and some means satisfactory to the engineer shall be used for compacting it. Such precautions shall be taken as will preserve the slopes and prevent improper segregation of materials. The object is to secure a compact, stable, reasonably impervious embankment, conforming to the prescribed lines. To allow for shrinkage and settlement, sufficient overfill not to exceed 10 per cent, shall be made by the contractor at the time of depositing the material. Where embankment is joined to a fill previously placed, or to a natural bank, a satisfactory bond shall be secured between the old and new materials by breaking the old surface or otherwise.

Embankment—Class E.—The term Class E embankment shall be used to include embankment for levees from material taken from borrow pits. It shall be constructed according to the specifications for Class D embankment, as set forth in Section 0.76 of the specifications.

Embankment—Class F.—The term Class F embankment includes such miscellaneous embankments or fills as are so designated on the drawings or by the engineer, in which no special requirements are made as to compacting.

Embankment—Preparation of Foundation. Unless otherwise directed the sites of embankments shall be prepared as regards clearing and grubbing, removal of buildings and soil stripping, as specified under Items 2, 3, and 5, to the end that all perishable or otherwise objectionable matter shall be removed. When, in the opinion of the engineer, sufficient soil has been removed, and material has been uncovered to provide a suitable foundation for the purposes intended, the surface of the material so uncovered shall be picked, plowed, or otherwise satisfactorily roughened, as directed, to make a bond with the embankment material.

Springs encountered in the base of the embankment shall be satisfactorily controlled by plugging, draining, or other approved methods. When advisable, springs shall be led into the outlet channel or away from the embankments, as directed. Approved excavation and materials for this purpose shall be paid for under the appropriate items.

The provisions of this section may be waived or modified as may seem desirable or permissible, in cases where Class F embankment is specified.

Embankment—Materials to be Used.—Embankments shall be made of acceptable materials from the excavations, or from borrow pits located on land provided by the district. Such materials shall be carefully selected and shall contain a sufficient proportion of fine particles to render the embankment reasonably impervious to water. The maximum size, quantity, and placing of large stones, shall be as allowed by the engineer. The material shall be sufficiently stable not to slide or slough at the prescribed slopes, under a condition of saturation. Where feasible to do so, all material from the excavations which are suitable for the purpose shall be placed in the embankment. No frozen material shall be placed in any portion of the embankment by any method whatsoever, nor shall any material be placed on a frozen surface, and operations shall be suspended when, in the opinion of the engineer, ice conditions are such as to be objectionable. Care shall be taken that no earth not acceptable for embankment purposes, or any roots, brush or other perishable material be incorporated within the embankment. All timber, posts, trestles, staging, etc., shall be removed to the extent directed by the engineer.

Where Class A, Class B or Class C embankment is specified, it is the intention that the outer portion of the dam shall be composed of coarse material which shall be permanently stable under a condition of complete saturation. Any material which has a tendency to slough, slide or wash when subjected to any condition which may reasonably be expected to occur, will not be acceptable. The center portion of the dam shall be composed of material containing sufficient clay or other finely divided particles to be highly impervious to water. To obtain these results the contractor shall use only carefully selected materials. Where the material from one borrow pit does not contain the requisite coarse and fine particles in the desired proportions, other sources shall be utilized, and if necessary to obtain satisfactory results, more than one class of material shall be deposited at the same time in the same or different portions of the embankment.

The provisions of this section shall not apply to Class F embankment, and may be waived or modified as to Class D embankment.

Embankment—Finishing Work.—The slopes and tops of all embankments that are to be dressed and grassed, or which are to remain exposed, shall be finished in a careful and workmanlike manner.

Embankment—Payment.—The embankment to be paid for shall include the quantity in cubic yards deposited in accordance with the drawings, specifications and instructions of the engineer, measured in embankment unless otherwise specified under the respective items for embankment and properly placed within the following limits: The prescribed neat limits for embankments, the contour of the natural ground or as left by the stripping, the prescribed limits for excavations the refilling of which is not included for payment under the provisions of Item 37, backfilling, and the outside neat lines of any structures included within the embankment.

The unit prices stipulated for embankment items shall cover the entire cost of constructing the embankments, including the cost of preparing foundations (except as provided in this section), excavating from borrow pits, pumping, sluicing, transporting, and grading of materials, placing, puddling, draining, compacting, trimming slopes, refilling settlements and depressions, and all labor and materials necessary for doing the work in accordance with the requirements of the contract, as well as the cost of maintaining embankments until the completion of the contract. But such prices shall not include the cost of clearing and grubbing, removal of buildings, soil stripping, surface dressing and grassing.

Coal Gas as Substitute for Gasoline.—The British Commercial Gas Association, which has been investigating the use of coal gas for driving motor vehicles, has issued a report stating that the gas may be advantageously used as a gasoline substitute by providing a large flexible holder for storing the gas.

Some Data on Depreciation in Value of Horses

Some interesting data on the depreciation in value of horses are given in a bulletin issued recently by the U. S. Department of Agriculture. This bulletin deals with the cost of keeping farm horses and the cost of horse labor. It is compiled from a study of records for 316 horses on 27 farms in Illinois, Ohio and New York.

In determining depreciation and appreciation in value of horses a yearly inventory value was placed on each horse on the farm by careful appraisal and a record was kept of each horse bought or sold. In Illinois 11 of the 18 yearly farm records showed a net depreciation of horses. In Ohio 7 of the 16 yearly records showed a net depreciation, and in New York 16 of the 18 yearly records showed a net depreciation.

The average net depreciation of the 316 horses was $4.50 per horse.* Of this amount $2.70 per horse was due to the death of 9 horses, valued at $855. Depreciation varied from $11.60 per horse in New York to an appreciation of $2.10 per horse in Ohio.

Table I shows the percentage of horses that appreciated in value, the percentage that did not, and the factors influencing the aggregate depreciation or appreciation, by States.

TABLE I.—PERCENTAGE OF 316 HORSES THAT APPRECIATED IN VALUE, PERCENTAGE THAT DID NOT APPRECIATE, AND THE FACTORS INFLUENCING THE AGGREGATE DEPRECIATION OR APPRECIATION, BY STATES (27 FARMS, 316 HORSES).

State and number of horses.	Percentage of horses that showed – Appreciation.	Percentage of horses that showed – No appreciation.	No. of deaths.	No. bought.	No. sold.	No. colts bought	No. colts sold.	No. colts fed.
Illinois (154 horses)............	18.75	81.25	3	21	21	2	..	43
Ohio (72 horses)...............	21.95	78.05	..	9	17	2	1	7
New York (90 horses).........	4.95	95.05	6	6	3	1	2	18
The 3 states (316 horses)....	15.60	84.40	9	36	41	5	3	68

On the Illinois and New York farms colts became work horses when from 2½ to 4 years of age. The age of work horses that depreciated in value varied considerably, depending on their usage and care. The average age of work horses that appreciated in value was about 4 years. The average age of those that neither appreciated nor depreciated in value was about 8 years, and the average age of those that depreciated in value was about 11 years. In Ohio data showing the age of all the horses studied were not obtained; however, the data that were obtained along this line showed about the same results as those in Illinois and New York.

In Illinois about 19 per cent of the horses appreciated in value at the rate of $36.05 per head per year, while the average depreciation for the other 81 per cent was $12.55 per head. At this rate it will be seen that a $36 appreciation of one horse practically would offset the depreciation of three others. Thus the appreciation of one horse out of every 5.34 kept resulted in an average net depreciation for all horses of but $3.46 per head. Of the 154 horses included in the records from this State 3 died, causing a loss of $350. In other words, the death loss was about 1 out of every 51. In considering the reason for the number of young horses on these farms and the low depreciation of work horses it was found that there was an average of one colt for every four work horses kept. Further, no colts were sold, all being developed into work horses, 11 becoming work horses during the time in which data were collected. It also will be seen that the same number of horses was bought as was sold. Three died and had to be replaced, and a part of the farmers enlarged their business, thus requiring more horses. With the continued raising and developing of colts into work horses, however, it is safe to say that ordinarily a greater number of young horses will be developed than will be needed in the farm business.

On the Ohio farms about 22 per cent of the horses appreciated in value at the rate of $56.90 per head. The average depreciation of the remaining 78 per cent was $13.30 per head. At this rate the appreciation of 1 horse would offset the depreciation of more than 4 other horses. Thus the appreciation of 1 horse out of every 4.55 resulted in an average net appreciation of $2.10 per head for the total number of horses. While no deaths occurred in this group, 2 horses were severely injured, entailing a loss of $175.

On the Ohio farms there was an average of one colt for every 10 work horses kept. This was about two-thirds less than on the Illinois farms, and yet the depreciation of horses was $5.56 per head less than in Illinois. By this it will be seen that the net appreciation of horses in Ohio was not so much due to the raising of young horses as in Illinois. A study of the data shows that the reason for this was that on some farms a practice was made of buying young horses, and after working them for a time, selling them at an increase in value. During the years this study was made 9 horses were bought and 17 were sold, 8 of the 17 having been on the farms at the time this work was begun. The horses bought and sold were mostly young draft stock, which accounts for the high appreciation of $56.90 per horse. In following this practice, at times more horses were kept than were needed to do the farm work. Other data in this bulletin show that the average horse worked less hours per year on the Ohio farms than on the Illinois or New York farms.

On the New York farms the relative number of horses that appreciated in value was a great deal less than in each of the other States—less than 5 per cent

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*Depreciation figures from other bulletins follow:

Bulletin 341 of the U. S. Department of Agriculture shows that the average depreciation of horses on 378 farms studied in Chester County, Pennsylvania, is $7 per head, and on 300 farms studied in Lenawee County, Michigan, $7.10 per head. These figures are largely determined by the practice of farmers in disposing of horses while they are still salable at a fairly satisfactory price, and would undoubtedly be much greater if all farm horses were kept until their usefulness was at an end.

Cornell University (N. Y.) bulletin 377 shows that the average annual depreciation of horses on 14 New York farms for the year 1912, and on 31 New York farms for 1913, was $14.03 and $12.10 per horse unit, respectively. Of the 45 farms studied, 12 showed an appreciation of horses.

Minnesota extension bulletin 15, covering a period of four years, 1904 to 1907, inclusive, gives figures for farms studied in three different counties. In Rice County depreciation varied from $0.98 in 1905 to $15.48 in 1904 averaging for the four years $5.56 per head. In Lyon County depreciation varied from $4.20 in 1905 to $9.86 in 1904, averaging per year $6.94 per head. In Norman County depreciation varied from $2.60 in 1907 to $7.37 in 1904, averaging per year $5.892 per head.

It is pointed out in the text that depreciation of the horse is an expensive item to farmers who are not able to control this expense by means of clever selling methods and by the use of young horses. Shrewd selling, however, does not affect the general principle of depreciation, since thus the loss is passed on to the buyer.

Minnesota experiment station bulletin 145 gives results of a further study of horse depreciation in the above-mentioned counties. Records for Rice County for the period 1908 to 1912, inclusive, shows a variation in depreciation from $0.28 in 1910 to $5.10 in 1909, and an average per year of $3.05 per head. In Lyon County the study covers a period of three years, 1908 to 1910, inclusive. The depreciation varied from $1.47 in 1910 to $5.60 in 1909 averaging per year $3.06 per head. In Norman County the work covered a period of four years, 1908 to 1911, inclusive. The depreciation varied from $0.51 in 1910 to $3.42 in 1911, averaging per year $1.48 per head. It is pointed out in this bulletin that the annual depreciation as shown above is not high enough to represent a proper average charge through a long term of years. Abnormal conditions in the Minnesota horse market were largely responsible for the low depreciation charge.

—at the rate of $44.40 per head. The depreciation per head of the remaining 95 per cent was $14.48. At this rate, the appreciation of one horse would a little more than offset the depreciation of three other horses. Thus, the average net depreciation was $11.56 for all horses. One reason for this depreciation being higher than in the other two States was a loss of $505 due to the death of 6 horses, or about 1 out of every 15. Thus, more than 48½ per cent of the total depreciation was due to deaths. The number of colts on these farms was less than in Illinois. For every work horse sold two were bought. It seems that these farmers have but recently started to replace the old horses by raising colts.

Some Notes on Pioneer Tunnel Method of Constructing Rogers Pass Tunnel

Further details regarding the methods of constructing the Rogers Pass Tunnel[*] of the Candian Pacific Ry. are given in the August Proceedings of the American Society of Civil Engineers by Mr. J. G. Sullivan, Chief Engineer of the railway, and Mr. A. C. Dennis, General Superintendent for the contractors.

As showing the probable economics of using the pioneer tunnel method, Mr. Sullivan quotes the following from his report of March 13, 1913, to officials of the Canadian Pacific Ry.:

> This method, of course, is only applicable where the rock will stand without artificial support, at least during the time of construction. Where the material must be artificially supported, then the top heading is the surest, and I think, the best way. The progress of the work by this method, as I said before, depends only on the speed that the pioneer tunnel can be driven. If rock is self-supporting, I see no reason why from 20 to 25 ft. per day could not be made. Placing the cost of driving the small tunnel at $30 per foot, that is the only part of the work that would be rushed under high pressure, and the heading proper can be taken out at least $5 per foot cheaper than if the work must be done under pressure, then the bench containing 18 cu. yd. per foot (neat section) can, on account of there being no interruptions to wait for drilling or cleaning up to put in breast holes or knocking down material in order to get pipes into the heading, at a low estimate, be taken out 75 ct. per cubic yard cheaper, or $13.50 per foot, which would make a saving in excavation of tunnel proper of $18.50 per foot, leaving $11.50 to be taken care of in interest saved account making greater speed. In my report to you of Oct. 22, 1912, I estimated an annual saving of about $226,000, but all my figures were very conservative, and I took into account only one or two of the larger factors of the extra expense. Mr. Bogue's more accurate figures show a saving of over $370,000. However, his estimate for fuel per h.p. hour was 40 per cent higher than the figure I used, and the price of coal was 17 per cent higher than the price I assumed. His price is more accurate than the one I used, but assuming, for the sake of being conservative, that the average between the two estimates would be approximately correct, that would mean, say $300,000 per year saving, to say nothing of the interest on the $3,000,000 or $4,000,000 that will be invested in construction, from which we will not be receiving any benefit until the work is completed. Therefore, if this tunnel can be completed one year sooner by using this method, the saving thus made will a great deal more than save the $11.50 additional cost of the pioneer tunnel

The results, states Mr. Sullivan, proved that these estimates were conservative. The pioneer tunnel, from the most careful studies of the information at hand, cost about $28 per foot instead of $30, as estimated. There was a great deal larger difference than 75 ct. per cubic yard between the actual cost of enlarging the tunnel by this method and the estimated cost of enlarging without the use of the pioneer tunnel; and another item, not taken into account in this estimate, was the fact that the pioneer tunnel only had to be driven less than four-fifths of the total distance.

It has been stated by some that this method is not applicable where there are soft spots in the rock. If the soft rock encountered does not exceed 50 per cent of the total, Mr. Sullivan is confident that this method would still prove more economical than any other which has yet been tried, for the reason that when the soft places are encountered, there is plenty of time to stope out the upper part of the arch and timber it, so that when the steam shovel arrives at those places, there will be no delay whatever, and, instead of having to stope out the entire section by hand, as is necessary in the under-heading method, only about half, or less, of the material in the section requires to be removed in this manner.

Regarding the actual costs Mr. Sullivan quotes further from the report of March 13, 1913:

> I figure that by this method the pioneer tunnel can be driven for about $30, the main heading for about $40, and that the bench can be taken out for about $54, making a total of $124. There will be incidentals; contractors' profit should not amount to over $20 per foot. Of course, this method of driving the tunnel, working so many drills at one time, will require a larger plant than if only one heading was driven, and that at a slower speed than we contemplate.

The expectations of the railway company, stated Mr. Sullivan, have been more than realized, as is proved by the speed and the cost of the work. The cost of driving this tunnel through rock, including in this price the cost of driving 19,610 lin. ft. of pioneer tunnel, 12 cross-cuts, each about 40 ft. long, erecting the plant (including freight), the proportionate cost of building about 5 miles of temporary railway tracks, and other overhead charges, plus 10 per cent on all expenditures, will amount to a little less than $5 per cubic yard for excavation in the tunnel proper.

In his discussion, Mr. Dennis, who was in charge of the work for the contractor, stated that the idea of the pioneer heading originated in the desire to get away from the congestion, smoke, general confusion, and interference of one operation with another, observed in tunnel driving, and to provide muck in large quantities for handling by shovel. His work in coal mines, with air course run with the main entry, suggested the pioneer as a means to the desired end.

Regarding the ventilation, Mr. Dennis stated that the Connersville blowers were used exclusively for exhausting from the working faces and would produce 7 lb. below free air pressure. This provided satisfactory ventilation through 12-in. pipe for 1½ miles, at which point a second blower was put in, working as a booster on the same pipe line.

The general wages paid were 40 ct. per hour to drill runners and 35 ct. per hour to others. The bonus probably averaged 25 per cent in addition to these rates.

Construction Started on $9,000,000 Ship Building Plant

Work has been started by the Aberthaw Construction Co., of Boston, on the building of a $9,000,000 plant at Quincy, Mass., for the Fore River Ship Building Corp. The plant will be used for building destroyers for the government. It will consist of a large number of small slips and the necessary manufacturing buildings. The land will be filled, a large number of piles driven, and a channel will be dredged 18 ft. deep from the property to the main channel. At the property itself mean low water level will be 17 ft. Since all the boats will be identical, principles of multiple production can be applied to their manufacture.

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[*] See Engineering and Contracting, March 21, 1917.

In addition to the main plant at Quincy there will be erected a $2,500,000 turbine plant at Buffalo and another $1,500,000 plant in Providence, R. I. The equipment from these plants will be shipped to Fore River as soon as completed.

The construction of plant itself will require more than 4,000 men, and the Aberthaw Company plans on having this full quota on hand by November. For the construction of the ships themselves the Fore River Corporation will need from 8,000 to 10,000 men at Quincy, 3,500 at Buffalo, and 1,000 at Providence. They will endeavor to obtain part of the necessary quota by offering positions to the men who are at present working on the construction of the plant.

The plant at Quincy will consist of a number of buildings, all of reinforced concrete and having an aggregate floor space of over 2,000,000 sq. ft. The ways will also be built of reinforced concrete and the plant will be permanent in every respect.

Obtaining and Retaining Track Laborers by the Railroads*

On sections or where locations of labor headquarters are a fixture, every effort possible should be made to encourage trackmen, either laborers or foremen, to own their own houses. A foreman should be given an idea of the permanency of his position by his superior and should, in turn, impart such knowledge to the men under him and make them feel that they have an interest, not only in their work, but in their home town. The number of men should be the same in winter as in summer. There is no more pernicious custom than in keeping the men in a section gang guessing during the summer months who will be retained and who will be laid off when the first snow begins to fly.

Section foremen should be permitted to hire their own men, and when there are laborers who cannot or will not rent or live in their own houses, they should have a bunk house provided by the company at a location convenient to the work; a plentiful supply of water, and where a certain amount of privacy can be obtained. This camp should be equipped with a cooking range and fixtures, and a cook of the same nationality as the men should be secured. He should be able to cook good, wholesome meals, have warm water for the men to wash in and keep their sleeping quarters clean and comfortable. This arrangement will always attract good laborers.

When a foreman cannot secure his own laborers they should be furnished by the company's authorized labor agent, but the labor agent's connection with them should end there. The custom of a labor agent furnishing the victuals and wearing apparel of the men they provide for the railway companies should be discouraged, as charges are made and deductions taken from laborers' wages, when this system is in force, that the men do not know of and which causes no end of trouble at pay day.

Men for extra forces or floating gangs should be hired by the foreman of the gang when it is possible, but in event that he is unable to do so, men should be furnished by an accredited labor agent employed by the company and working on a salary, to preclude any possibility of charging men or parties of men commission for their jobs—his sole duty being to get men from their source and deliver them to the foreman at the post needed and where there should be all the necessary conveniences, either boarding shanties or bunk cars. Those should be provided with double deck steel bunks, good ventilation, wash basins, water coolers, and other facilities—a dining car or dining room well ventilated and sanitary, and cooking car or compartments provided with all cooking utensils and a place for storage of supplies.

If Italian labor is employed the above arrangement may not apply, as they prefer to do their own cooking, and in such cases only good sleeping quarters are needed, with plenty of water and other sanitary arrangements, and a place provided in charge of a storekeeper where they can secure the commissary articles that they use.

To retain laborers once we do secure them is often easier said than done, and just so long as companies and individuals can offer better inducements than the railroads do, our men will leave us and go where they get the most for their labor.

The remedy is—first, the compensation we give our laborers and the manner in which we provide for housing and feeding them; next, the usage we accord them by way of furnishing them motor-driven cars to carry them to and from their work. It is nothing new to the supervisor of tracks where hand-pumped cars are used to see men leave him and go to roads where motor-driven cars are used. All other mechanical tools consistent with the work should be used.

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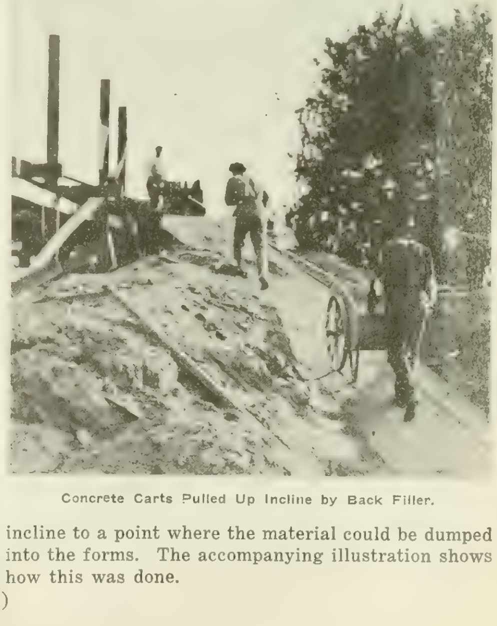
*From a committee report presented to the recent convention of the Roadmasters and Maintenance of Way Association.

Back Filler Pulls Concrete Cart Up Incline

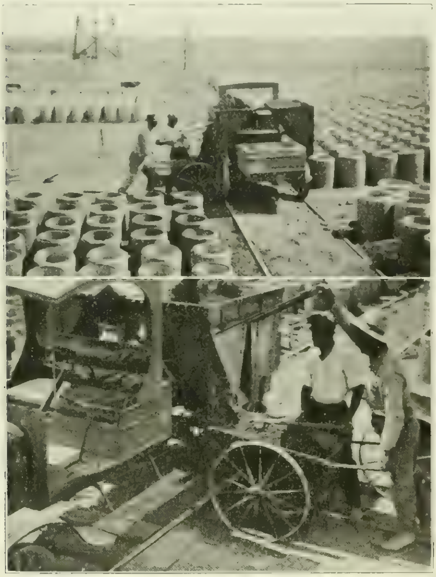
In the construction of a reservoir at Pasadena, Cal., the contractors, Bent Bros., Los Angeles, Cal., employed a back filler for pulling concrete carts up an incline to a point where the material could be dumped into the forms. The accompanying illustration shows how this was done.



Concrete Carts Pulled Up Incline by Back Filler.

Conveying Concrete in Bins Saddled Across Automobile

Twin steel bins saddled across a Ford automobile, as shown in the accompanying illustration, were employed by Bent Bros., contractors, Los Angeles, Cal., for delivering concrete from the mixing plant to the crews engaged in making concrete pipe. Each bin held approximately 1 hand cart load of concrete. The pipe is being used in the construction of a 125-mile irrigation system at Henrietta, for which Bent Bros. are the contractors.



Delivering Concrete by Automobile Operating on Track.

New Prices for Steel

President Wilson has approved an agreement between the War Industries Board and the steel men, fixing the following maximum prices, which became effective immediately, and are subject to revision Jan. 1, 1918:

Commodity.	Price agreed upon.	Base.
Blooms and billets 4 by 4 in. and larger	*$47.50	Pittsburgh and Youngstown
Billets under 4 by 4 in.	*51.00	Pittsburgh and Youngstown
Slabs	*50.00	Pittsburgh and Youngstown
Sheet bars	*51.00	Pittsburgh and Youngstown
Wire rods	*57.00	Pittsburgh
Shell bars:		
3 in. to 5 in.	†3.25	Pittsburgh
Over 5 in. to 8 in.	†3.50	Pittsburgh
Over 8 in. to 10 in.	†3.75	Pittsburgh
Over 10 in.	†4.00	Pittsburgh
Skelp:		
Grooved	†2.90	Pittsburgh
Universal	†3.15	Pittsburgh
Sheared	†3.25	Pittsburgh

*Gross tons. †Per 100 lb.

Blasting Boulders

Large numbers of boulders were encountered in the excavation for the Cape Cod Canal. These boulders were located by sweeping and by divers, and were removed either by hoisting in slings, attached by the divers, by large steam lighters, or were broken by blasting and the pieces disposed of. The blasting was done usually by placing charges of dynamite on top of the boulder, depending on the overlying water to act as tamping. The explosive used was du Pont 75 per cent gelatine dynamite, the charge varying from 25 to 200 lb. The best results seemed to be produced by charges of about 50 lb., even if they had to be repeated, the second and subsequent charges being inserted in the fissures made by the first. Boulders as large as 80 tons were thus disposed of; the total number handled by divers, either by blasting or slings, was about 700, weighing in the aggregate perhaps 3,500 tons.

Personals

Lee R. Cooke has been appointed city engineer of Nampa, Idaho.

Robert W. Thompson has been appointed district engineer for the Government of British Columbia, with headquarters at Kamloops, B. C.

G. S. Plumley, for the past 10 years chief engineer of the Blue Creek Coal & Land Co., and the Kanawha & West Virginia R. R. Co., has opened offices at Charleston, W. Va., where he will engage in private practice in civil and mining engineering.

L. H. Palmer, general manager of the Eastern Pennsylvania Railways System, at Pottsville, Pa., has been appointed assistant to the president of the United Railways & Electric Co. of Baltimore, Md. Before accepting the position with the Eastern Pennsylvania Railways System in April 1916, Mr. Palmer had been in Baltimore for ten months. Before that he was superintendent of transportation of the New York Rys. Co., and its predecessors, the Metropolitan Street Ry. Co., in New York City, for about 5 years. While general manager of the Eastern Pennsylvania Railway System Mr. Palmer was identified with the J. G. White Management Corporation.

Geo. B. Fost & Sons, architects, and Ernest P. Goodrich, engineer, have associated professionally in the practice of architecture, engineering and city planning. Geo. B. Post & Sons have been the architects for many prominent buildings in this country, among them the Wisconsin state capitol, the College of the City of New York, the New York Stock Exchange, the Prudential Life buildings in Newark, the Statler Hotels in Cleveland, Detroit and St. Louis and numerous banks, office buildings, hospitals and other structures in New York and other parts of the country. Ernest P. Goodrich is a consulting engineer of national reputation and has served as consulting engineer to New York City, Newark, Portland, Ore., and many other municipalities. He is the designer of the Bush Terminal in South Brooklyn and is the director of the Bureau of Municipal Research. A. Pearson Hoover, associate of Ernest P. Goodrich, is an authority on grade crossing elimination and industrial developments and is the engineer for the Paterson (N. J.) Industrial Development Company. George B. Ford of the firm of Geo. B. Post & Sons has served as consultant on city planning to a score of cities in America. In all of this work he has co-operated with Mr. Goodrich and together they have made city planning investigations or prepared plans for Jersey City, N. J.; Newark, N. J.; Omaha, Nebr.; East Orange, N. J.; Mansfield, O., and a number of other places. The object of the closer association between the two organizations is to permit of a wider latitude of practice and more intensive co-operation in the design and execution of engineering and architectural work in general and in particular in city planning, workingmen's housing and industrial developments.

Industrial Notes

The Walter A. Zelnicker Supply Co., St. Louis, Mo., has secured recently the services of Mr. W. H. Bramman, who is acting in the capacity of assistant to the President. Mr. Bramman before becoming associated with the Zelnicker Supply Co., was connected with the American Carbon & Battery Co.

Wm. A. Hart, formerly in the advertising department of the Burroughs Adding Machine Co., has joined the advertising staff of the Detroit Steel Products Co. as assistant advertising manager. For the past year Mr. Hart has lived in San Francisco, where he was western advertising manager for the Burroughs Company. While in that position he traveled over the greater part of the west collecting advertising material and data in the various Burroughs territories.

The Machinery and Machine Tool Trades Committee of Greater New York, organized to aid in floating the second liberty loan, has established headquarters at 334 Fourth av., New York City. J. W. Lane, President of the E. W. Bliss Co., is chairman of the division. H. R. Swartz is vice chairman, Geo. J. Low is Secretary and Charles A. Hirschberg, Publicity Member. Among the men prominent in the machinery world, co-operating in the work are Henry Prentiss, President Prentiss Tool & Supply Co., 129 Broadway, New York; George Doubleday, President Ingersoll-Rand Co., 11 Broadway, New York City; R. L. Patterson, President American Machine & Foundry Co., 511 Fifth Ave., New York City; C. I. Cornell, Treasurer Pratt & Whitney Co., 111 Broadway, New York City; Henry Fuller, Vice President Fairbanks-Morse & Co., 30 Church St., New York City; John H. Lidgerwood, President Lidgerwood Mfg. Co., 96 Liberty St., New York City; A. J. Babcock, President Manning, Maxwell & Moore, 119 W. 40th St., New York City; Norman Dodge, Vice President Mergenthaler Linotype Co., Tribune Bldg., New York City; H. R. Swartz, President Intertype Corp., 63 Park Row, New York City; Geo. J. Low, F. M. Dyer & Co., 24 Broad St., New York City.

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Volume XLVIII. CHICAGO, ILL., OCTOBER 24, 1917. Number 17.

ATTENTION!

Turn back three pages to advertising page 12. The publishers of Engineering and Contracting have there printed a message that should interest you.

Shall "Extra Work" Be Called "Unclassified Work"?

Although the term "extra work" is one that has long been used to designate work not covered by unit prices or lump sum bids, there are objections to the term. The objections are so strong that one well-known firm of consulting engineers uses the term "unclassified work" instead of "extra work," as explained by Mr. E. E. Howard in a letter printed in another column.

As Mr. Howard points out, a certain stigma attaches to the words "extra work." They connote work that was not foreseen by the engineer, and therefore imply lack of study of the construction problem in advance of awarding the contract.

On the other hand, the expression "unclassified work" suggests minor items that were not important enough to classify and enumerate in advance. It seems to us that there is merit in this change of terms, for it can cause no confusion and it eliminates a false impression that has become prevalent.

Should the Title "Consulting Engineer Be Abandoned?

Prof. George C. Whipple, of Harvard, asks this question and gives an affirmative answer. He points out that the title "consulting engineer" was not frequently used until 1900, but that in the last seven years it has become very common. He regards the title as being a misnomer unless the user of it acts purely in a consulting capacity.

While recognizing that there is strength to such an objection, we are inclined to believe that a good case can be made out for the prevalent use of the title "consulting engineer" even where the engineer himself designs entire works for clients. Without doubt an engineer who is on the regular pay roll of one company and of no others, is not a consulting engineer in the ordinary acceptance of the term. To differentiate a regularly employed engineer from one who serves different clients on special jobs, some special appellation seems desirable. Some independent practitioners in the engineering profession chose the term consulting engineer. They might have called themselves advisory engineers, but the adjective advisory doubtless seemed to limit the scope of their activities. At any rate they regarded themselves as independent consultants, who might or might not undertake to supervise the details of design, and they selected the term "consulting engineer" to differentiate themselves from other engineers who depend on salaries rather than fees for their remuneration.

The Decreasing Use of Lumber

In 1906 the per capita consumption of lumber in America was 516 board feet. In 1915 it had fallen to 375 board feet, a reduction of nearly 28 per cent. The greater use of concrete, steel and wood pulp products account mainly for the falling off in the use of lumber.

Wood pulp products include wall board, plaster board, "ready roofings" made largely of paper, and "fiber" board.

Shingles have been so extensively replaced by "ready roofing" and other substitutes that scarcely more than half the roofing now laid annually consists of shingles. Wall and plaster board annually take the place of more than 300,000,000 sq. ft. of lath and plaster, or nearly 20 per cent of the total area of lath and plaster laid.

In 1915 the various substitutes for lumber took the place of more than 8,000,000,000 board feet, or 21 per cent of the total lumber consumption in America.

A 78-page bulletin (Report No. 117) just issued by the U. S. Dept. of Agriculture gives a comprehensive review of "The Substitution of Other Materials for Wood," and outlines the methods that lumber producers must employ to meet the growing competition of lumber substitutes. It is admitted, of course, that lumber can not hope to compete successfully with substitutes under certain conditions; but lumber manufacturers are advised to adopt modern methods of standardizing, improving and marketing their products. Standard classifications and specifications, research to develop improved methods of preservation, and advertising are suggested as means to this end. We quote:

> Lumber is no longer a necessity and must be sold largely in competition with other materials, hence merchandising methods at least as modern and efficient as those of its competitors are necessary. This involves effective advertising, well-standardized manufacture, grading rules which consumers can understand and which meet their actual needs, together with a thorough-going scientific as well as practical knowledge of the product, an inspection service which insures delivery to purchasers in

accordance with specifications, and an organization which makes possible the adjudication of difficulties outside of the courts. If, as in the case of the wooden silo, lumber has lost half of its market largely through the aggressive merchandising of its competitors, further loss may at least be reduced through exact knowledge of the proper manner in which to build wooden silos and by getting this knowledge effectively into the hands of prospective builders. If the wooden shingle has lost half its market mainly through its susceptibility to fire and the capital which has been made of this fact, the most logical method of preventing further loss would be to make the wooden shingle fire resistant. Competing industries have probably undertaken and solved problems at least as difficult.

Many of the activities which are necessary to secure for lumber the place in trade to which its properties and characteristics entitle it are among the legitimate functions of trade associations and can be undertaken to better advantage by the association than the individual: Regional advertising and the advertising of the value of products for particular purposes and similar features of aggressive merchandising; the establishment and maintenance of lumber grades and specifications, with such special services as responsible inspection; the adaptation of the forms and methods of manufacture to the requirements of the trade; studies of efficiency in all of its ramifications; the furnishing of scientific information along various lines to the public and of special information concerning trade conditions to the industry; and the research necessary to secure basic data. With adequate safeguards through control by some such agency as the Federal Trade Commission and through publicity, associated efforts should be encouraged to secure efficiency in the industry.

The Difficulty in Chuting Concrete in Cold Weather

In very cold weather concrete may became so stiff that it will not flow readily through chutes, and under such conditions concrete buggies are frequently used. But the question arises whether it is not feasible to keep the concrete warm enough throughout its journey from the mixer to the forms, to permit the use of chutes even in the coldest weather. Should not the bucket that hoists the concrete be lagged on the outside with some sort of heat insulator? Should not the chutes themselves be similarly lagged?

We think the problem can be solved by heating the aggregates and by making provision for heating the concrete while it is in the mixer, followed by using heat insulated buckets and chutes. Should not the drum of the mixer itself be lagged?

"Do the National Engineering Societies Discredit Engineering Education?"

Prof. J. R. Benton, dean of the College of Engineering of the University of Florida, puts the above-given question in the September Bulletin of the Society for the Promotion of Engineering Education. While he says that the answer to the question is "No," nevertheless there is some evidence "which might seem to call for an affirmative answer" if taken by itself.

The constitution of the American Society of Civil Engineers specifies that graduation from a school of engineering shall be considered as equivalent to two years of active practice. Prof. Benton pertinently asks why a boy who spends four years in high school and four years in an engineering college should receive only two years' credit in experience, while a boy who leaves grammar school and starts as a chainman in a surveying party, may earn eight years' credit for engineering experience by the time the college graduate has earned two.

If the college graduate is to be penalized because of lack of experience, should not some equivalent penalty attach to the man of experience who lacks a college training? In short, should not the engineering societies revise their requirements for membership in their different grades, so as to give more adequate recognition to the worth of technical education?

Heating Concrete Aggregates by the Car Load

Last winter the Thompson-Starrett Co. erected a reinforced concrete building for the American Can Co. at Maywood, Ill. They built a wooden shed in which 12 cars of sand and gravel could be housed at one time. Canvas curtains closed the end of the shed at which the cars entered. Double tracks ran the full length of the shed, and a line of steam radiators was laid between the rails of each track. Six lines of steam pipes ran along each wall. In this manner it was possible to maintain a temperature of 110° in the shed when it was 10° below zero outside.

The sand and gravel were shoveled from the cars into wheelbarrows that delivered into a mixer outside the shed.

In addition to the advantage of keeping the aggregates warm, the shovelers themselves were kept comfortable during bad weather—a consideration not to be overlooked.

Why Engineering-Contractors Secured Most of the Cantonment Construction

Of the 16 cantonment contractors 12 may be definitely classified as engineering contractors. This, at first sight, seems remarkable, for the cantonment construction consists largely of buildings, and it would therefore be assumed by most people that building contractors would have secured nearly all these jobs. Why did engineering contractors fare so well in the vigorous competition to secure these contracts?

To begin with, every one of the 12 engineering-contractors has done more or less railway construction under conditions that necessitated the rushing of work with very large forces of men. Relatively few building-contractors were able to show records that conclusively established their ability to do rush work on a large scale.

In the next place, a large part of the cantonment work consisted in building streets, waterworks and sewers; and on this sort of work few building-contractors could qualify.

Thousands of engineering-contractors erect buildings as a part of their general contract work. Hence, although they do not specialize in building construction, they are competent to undertake many classes of building work.

It is a noteworthy fact, also, that engineering periodicals have published more and better information on methods of constructing buildings than have been published by architectural periodicals. Incidentally this has served to advertise the engineering-contractors whose work has been described. Who can say how great a factor this advertising has been in giving engineering-contractors the prestige upon which they rely in securing "cost plus a fee contracts?"

Design of Concrete Box for Loading of Crushed Stone

To the Editor: The accompanying sketch shows the design of a tunnel that was recently constructed to permit drawing crushed stone from the storage above. With the storage full the height of the pile of stone will be about 50 ft.

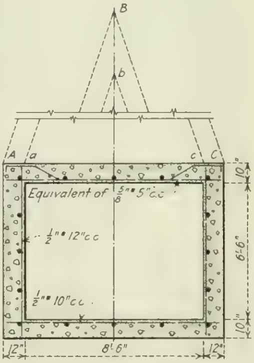
As shown, the design is similar to a box culvert. There was no valid reason, however, why a box section should have been adopted. Footings under the walls and a thin unreinforced floor slab would have answered all requirements.

The man responsible for the design had conceived the idea that somehow the load applied to the roof of the tunnel became greatly reduced when reaching the foundation. Hence, the reduction in the thickness of the floor slab and the amount of its reinforcement.

That this man is not alone in his belief is evidenced by a number of articles on box culverts, in some of which are shown cross sections with the floor of the same thickness as the roof, and others in which the floor is regarded as of less structural importance than the roof.

Why this should be I cannot understand. It seems clear that the floor of the tunnel is subject to not only the load on the roof slab, ac, but the load across the entire top of the tunnel, AC, plus the weight of the tunnel itself. To assume that the friction of the earth on the walls of the tunnel assists in carrying the load is wrong. It is just as likely to cause an increase in the load.

We shall assume that the roof is correctly designed. Its resisting moment per lineal foot of tunnel is 10,800 ft. lb. (Omitting negative moment at the corners.) The weight of the roof slab is 1,275 lb. Its bending moment is 1,355 ft. lb. The resisting moment available for live load is 9,445 ft. lb.


B
b
A
a
c
C
Equivalent of $\frac{5}{8}$" ■ 5" c.c.
$\frac{1}{2}$" ■ 12" c.c.
$\frac{1}{2}$" ■ 10" c.c.
10"
6'-6"
10"
12"
8'-6"
12"

Sketch of Proposed Concrete Box.

The weight of the triangle, ABC, per lineal foot of tunnel is 10,200 lb. The weight of the tunnel is 4,838 lb. per lineal foot. The weight of the tunnel and superimposed load is 15,038 lb. Dividing this uniformly across the bottom of the tunnel we have 1,432 lb. per foot. Deducting the weight of the floor slab from the upward pressure of the soil, we have 1,110 lb. producing a bending moment of 11,804 ft. lb. This requires a slab with a distance of 10.5 in. to the reinforcing steel or a total thickness of about 12.5 in.

It would seem then that a floor slab of at least the thickness of the roof would be required in good design.

The above analysis differs from the accepted method for box culverts with an earth fill, but there is scarcely a doubt that crushed stone imposes triangular loading.

C. O. Sandstrom.

515 Republic Bldg., Kansas City, Mo.

The Bureau of Buildings of New York City has issued a new edition of the city building code.

An Unusually Complete "Extra Work" Clause

To the Editor: After reading the editorial under the above caption, in your issue of Oct. 17, page 303, I came to the conclusion that the engineering profession is a conservative one.

Referring to the requirement, specifications, the Miami Conservancy District, Extra Work: "The contractor shall at the end of each day during the progress thereof furnish to the engineer daily time slips showing the name or number of each workman, etc., etc."

In 1887, just 30 years ago, the writer was connected with the construction of the Norfolk & Western R. R. in Virginia, of which W. W. Coe, M. Am. Soc. C. E., was chief engineer. A very elaborate system of reports was used there, on extra work, daily, weekly and monthly, with thorough and absolute checking by the assistant, resident and division engineer. Articles covering this system can be found in the Transactions American Society of Civil Engineers, in back numbers of Engineering News and Engineering and Contracting. The same system was also in vogue in grading the streets of Norton, Va., junction of the Norfolk & Western and Louisville & Nashville R. R.

Emile Low,
M. Am. Soc. C. E.

Buffalo, N. Y.

"Unclassified Work" Clause in Construction Specifications

To the Editor: Your editorial headed "An Unusually Complete Extra Work Clause" and the clause quoted from Mr. Morgan's specifications, in Engineering and Contracting of Oct. 17, are of special interest in calling to attention the advantage of explicit wording in such clauses. Clause 10 of the enclosed Section R-O of our standard construction specifications covering the relations and obligations of contractor, purchaser and engineers, covers the same sort of work somewhat more briefly and has been used in a great many of our contracts in the last few years. You will notice that we allow 20 per cent on the cost of materials and applied labor, while Mr. Morgan allows 15 per cent, but includes liability insurance, etc. There is one variation, however, which has occasional application in the case of "completed articles or products ready for installation." For instance, we occasionally order a motor or some piece of machinery through a contractor to avoid the complication of advertisement, meeting of commissioners or some other complication incident to a special contract for such a purchase. It seems fair that the percentage should be less on such items.

The special feature to which I would call your attention, however, is the title. We do not refer to such work as "extra work," but as "unclassified work," and we use this term in part for its psychological effect upon the purchaser. Very frequently clients, especially in the case of public bodies, are inclined to grumble over extras because they ordinarily think of an extra as something the engineer has not thought of. The term "unclassified work" at once suggests to the mind that the work in question is something which is not classified with the major portion of the undertaking. I believe that by far the larger part of work which is done under such clauses is not extra in the sense that the engineer did not think about the work until its necessity occurred, but rather that he found it inexpedient or inconvenient to include it in a classification. For instance, in a recently completed contract for substructure which totaled about $500,000 the remodeling of certain existing small buildings was necessary. This work could not be classified with the basis of piers, concrete in shafts or timber piles, and had we prepared very complete plans of the work to be done and asked a lump sum bid, the prices bid by any careful bidder would undoubtedly have been greatly in excess of the actual cost because the cost of altering the buildings, which was about $5,000, was so small a percentage of the total contract that it would not effect the competitive bid very seriously. Yet the necessity of altering these buildings was known from the time the plans were prepared and the work in no sense was extra or unthought of.

We recommend the use of the term "unclassified work" instead of "extra work." It is more properly descriptive, definite and explicit. It is more fair to the engineer, to the contractor and to the purchaser—to the engineer because it does not leave the impression that his plans were defective and incomplete; to the contractor because numerous unclassified work bills do not leave the impression that the contractor is trying to get something extra; and to the purchaser, who is often a layman, because it gives him a more correct understanding of the fact that the method of payment is one adopted for minor items, really for his own convenience and advantage.

E. E. Howard,
Harrington, Howard & Ash,
Consulting Engineers.

Kansas City, Mo.

[The clause regarding unclassified work referred to by Mr. Howard follows.—Editor.]

UNCLASSIFIED WORK. The engineers shall have the right to require the contractors to perform work or supply materials of a class not provided for in the specifications or for which no special price for payment is provided in the contract, to be known as Unclassified Work. In case such work or materials are ordered, they shall be paid for on the basis of actual cost to the contractor of materials and applied labor plus twenty per cent thereof for his profit, indirect expenses, and for the use of plant, tools, and appliances. No indirect expenses of any kind shall be included in the cost of materials and applied labor. In case completed articles or products ready for installation are furnished instead of the constituent materials, the contractor will be allowed ten per cent on the cost to him of such articles for profit, indirect expenses, and for use of tools and appliances. No allowance will be made for superintendence, insurance, or any other indirect expense, or for the use of plant, tools and appliances. Satisfactory vouchers will be required from the contractor for all items of expense incurred in unclassified work.

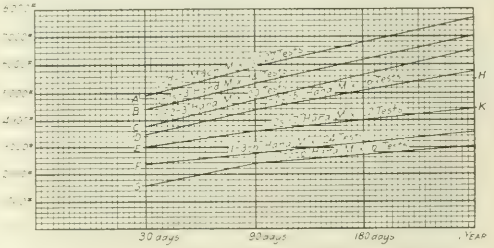
No bills for unclassified work will be allowed unless the work was ordered before execution in writing by the engineers, and every claim for unclassified work, for extra work, for additional allowances, not specifically enumerated in the contract, must be presented to the engineers for allowance by the last day of the month following the month in which it was done or furnished. Otherwise all claims for such items shall be deemed to be and hereby absolutely waived by the contractor, and the purchaser shall not be required to make any payment on such accounts.

New Heavy Duty War Trucks Accepted by Government.—The first two heavy-duty war trucks which the Quartermaster's Department of the Army, assisted by the automotive products section of the Council of National Defense and the Society of Automotive Engineers, has designed, were officially accepted by the Secretary of War on Oct. 19. The delivery and acceptance of these trucks marks the completion of a task that sets a new record in design and production in automobile history.

Some Compression Tests on Concrete Cylinders

To the Editor: Enclosed please find results of compressed tests on 8/16 and 6/12 concrete cylinders. The tests are directly comparable as they were made with the same cements and aggregates except in the last instance. Similar conditions were observed as to proportions, consistency and curing. The tamping of the hand mixed specimens was by the same methods of procedure in the endeavor to procure like conditions. All the concretes were of a sticky, plastic consistency readily workable in reinforced construction.

From the uniformly high results there would appear to be a wider latitude in the selection of working stresses than is allowed by existing building ordinances. In the few instances where deformations were measured for the rich mixes, a modulus of 5,000,000 to 6,000,000 was readily obtainable. With concretes of like character as regards aggregate and cement, like consistency and proportioning and curing, we might readily assume working stresses of 1,000 lb. to 1,200 lb. in compression when the steel is stressed from 16,000 lb. to 18,000 lb. for 1 to 5 and 1 to 3½ mix and 700 lb. to 900 lb. for the 1 to 9 and 1 to 7½ mixes, respectively.



Compression Strength of 30 and 90-Day Cylinders.

Local cement and Stelacoom aggregates. Cylinders cured in moist sand.

A-B-C—8 to 8¼ per cent mixing water. Clean cut washed gravel and sand.

D-E-F—6½ to 7½ per cent mixing water. Clean cut washed gravel and sand.

G—Aggregates poorest material in the locality.

H—27-year-old cube, 1-3-5 mix, from High School foundation.

K—2-year-old cube, 1-3-6 mix, from paving base.

Hand mixed cylinders—3 times dry, 6 times wet.

One-year-age is probable strength of this period.

The machine mixed concrete was from the mixer on paving work and represents good average practice. The hand mixed concrete was carefully manipulated and represents good modern practice, work that can be obtained on any intelligently managed job.

Tacoma, Wash. Russell J. Borhek, C. E.

Board of Experts to Handle Public Works in France

By a decree of the President of France there has been created in the Ministry of Public Works a board of directors—experts chosen from various walks in life—to actively assist the Minister in the initiation and execution of public works, and also in deciding upon bids tendered by contractors. This "Conseil Superieur" will consist of 21 members, appointed for three years, and it will be divided into four sections as follows: 1. Highways (roads, policing of roads, automobiles, and distribution of electric energy). 2. Navigation (management and utilization of waters, for instance, in the matter of floods and hydraulic engineering). 3. Ports (harbors, lighthouses, and coast defense). 4. Railroads.

Strength of Nail Joints in Douglas Fir and Western Hemlock

Tests to determine the strength of nail joints made with wire nails used in single shear in Douglas fir and hemlock timber have been made by the Bureau of Buildings of Portland, Ore. The tests were conducted under the direction of Mr. Henry Blood, Engineer of the Bureau. The results obtained are described in a recently issued report, which was put into its final condition by Mr. H. E. Plummer, Inspector of Buildings.

The report covers the testing of 110 joints, of which 87 were made of Douglas fir and 23 of western hemlock.

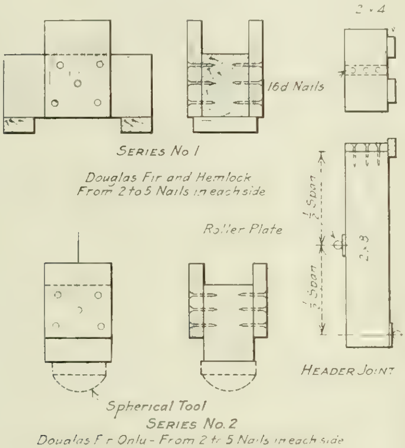


Fig. 1—Types of Joints.

The tests were divided into two series, depending upon the style of the joints (see Fig. 1). In the first series, two side pieces, each with the grain of the wood vertical, were nailed to a center piece with the grain of the wood horizontal.

For the second series, two side pieces, each with the grain of the wood vertical, were nailed to a center piece with the grain of the wood also vertical.

In the first series, joints both of Douglas fir and western hemlock were tested, but in the second series, joints only of Douglas fir were tested. In making the tests, it was desired to introduce such variables that the lateral resistance of nails under various conditions be quite clearly brought out and understood, and with this in mind, the number of nails in a joint, the size of the nails, as well as the size of the side and center pieces were varied. The size of the side pieces varied from 1-in. by 6-in. to 2-in. by 8-in., and the center pieces from 4-in. by 6-in. to 6-in. by 10-in., the dimensions given indicating commercial size which varies from ⅜-in. to ¼-in. less than the dimensions given. The nails used were common wire nails, ranging from 10 penny to 60 penny in size and the number of nails used in each side piece varied from two to five. The size of the pieces was such that nails had a penetration in the center piece of from 30 per cent to 80 per cent of the length of the nail, but in all cases, the nails were used in single shear, in no case passing through the center piece. All timbers were surfaced so that contact in the joints was between planed surfaces only.

The joints were tested by placing them in a Riehle testing machine and forcing the side pieces down and by the center piece. Accurate measurements were taken of the relative movements of the pieces making up the joints. In addition to the two series of tests, two joints were tested in which the nails were driven parallel to the grain of the wood.

The following is a summary of the results obtained by the tests. The average ultimate load carried per nail is as follows:

SERIES NO. 1—DOUGLAS FIR.

No. of tests	Size of nail. Penny.	Ultimate load carried per nail
[illegible]	10	525
[illegible]	16	600
10	20	719
[illegible]	30	922
	40	1,183
1	60	1,800

SERIES NO. 2—DOUGLAS FIR.

No. of tests	Size of nail. Penny.	Ultimate load carried per nail
	10	407
	16	628
[illegible]	20	751
[illegible]	30	992
[illegible]	40	1,023
1	50	873

SERIES NO. 2—WESTERN HEMLOCK.

No. of tests	Size of nail. Penny.	Ultimate load carried per nail
[illegible]	10	519
	16	588
[illegible]	20	695
[illegible]	30	579

An inspection of the above values shows the irregularity and apparent unreliability of the single test made on the 50-penny and the 60-penny nail joint. The resistance of the 50-penny joint for some reason was low, while the resistance of the 60-penny joint was high. That this must be the case can be readily seen when the results obtained by other investigators are examined. Also a curve of the values for the lateral resistance of nails as indicated by the tests shows uniformity for the 10-penny, 16-penny, 20-penny, 30-penny and 40-penny nails, but shows pronounced breaks for the 50-penny and 60-penny nails. (See Fig. 2.) The average ultimate load per nail carried by header joint with nails driven parallel to the grain in the wood was for 16 d. nails, 446 lb.

The following conclusions, based on the tests, are given in the report:

The tests indicate that safe values for nails driven in perpendicularly to the grain in Douglas fir or western hemlock with a load perpendicular to the length of the nail are:

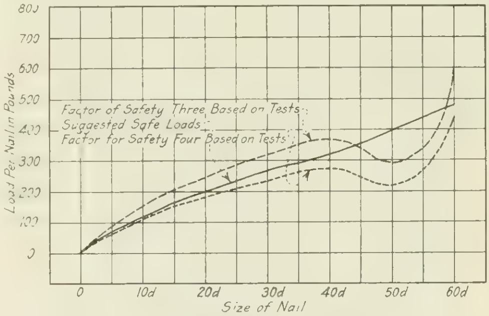


Fig. 2—Safe Loads on Nails.

	Lb.
10-penny nail	120
12-penny nail	120
16-penny nail	160
20-penny nail	200
30-penny nail	270
40-penny nail	320
50-penny nail	400
60-penny nail	480

These values should be reduced if the penetration of the nail in the holding piece is less than 50 per cent of its length. They give a factor of safety based on the ultimate load of considerably over three in all cases and in most cases of nearly four.

The resistance of nails driven perpendicularly into timber with the grain of the wood parallel to the loads is but little more than for nails similarly driven with the grain of the wood perpendicular to the load. This difference is so slight that loads recommended are the same for each case.

The test of nails driven with the grain of the wood indicates that the safe loads given in the previous conclusion for nails driven perpendicular to the grain of the wood should be reduced 25 per cent. The safe loads for nails driven parallel to the grain of the wood with a load perpendicular to the length of the nail are:

	Lb.
10-penny nail	90
12-penny nail	90
16-penny nail	120
20-penny nail	150
30-penny nail	200
40-penny nail	240
50-penny nail	300
60-penny nail	360

Tests were made on the 16 d. size only but the reduction in safe loading was considered to be the same over all nails.

The tests show that nails in western hemlock have so nearly the same resistance as in Douglas fir that the values may be considered the same.

Slip occurs under quite small loads and increases in proportion to the load until the ultimate load is reached, at which time slip continues with a decreasing load until failure occurs.

In the tests, no elastic limit of joints could be determined but the recommendation of previous investigators that a slip of 1/10 in. be considered as an elastic limit seems reasonable as the load with such an amount of slip varies from 50 per cent to 60 per cent of the ultimate load carried.

The amount of slip is affected by the time element and increases slowly over loaded periods of 3 to 8 minutes. For Joint No. 8 the slip occurred at the rate of .003 in. per minute for 3 minutes for a load one-half of the ultimate and increased with increasing loads to .02 in. per minute just before the ultimate load was reached.

When the load is released after a small amount of slip has occurred, the joint does not entirely come back to its former position and retains from 1/16 to 1/10 in. permanent set. Upon reloading to the amount of the first load, the slip did not increase beyond the original amount.

The tests indicate that the nail heads are of proper proportions as there seemed to be no difficulty in connection with the nail head pulling through the outside timber.

The strength of the joint seemed to be affected but little by the penetration of the nail in the center piece, if the penetration of the nail in the center piece was 40 per cent or more of its length, but with lesser penetrations the loads were reduced and for a penetration of 30 per cent the strength reduction amounted to about 25 per cent.

Each nail in a joint seems to support an equal proportion of the load.

Large nails do not offer as much lateral resistance as the smaller ones, proportionately or per pennyweight.

It is of interest to note that the bearing of a nail on wood when the joint approaches the ultimate load is greatly in excess of values given for ultimate crushing strength of timber across the grain. In connection with the use of timber, it would seem to be quite well to take into consideration that under certain conditions the loads imposed on timber across the grain may exceed the values commonly allowed.

The two principal factors involved in the strength of nailed joints are the resistance of the timber to crushing and of the nail to bending. The resistance of the nailed joint, if depending solely on the resistance of the wood to crushing, varies as the diameter of the nail, other things being unchanged. On the other hand, the resistance of the joint if depending solely on the resistance of the nail to bending, varies as the cube of the diameter of the nail. As the resistance of the nailed joints depends on both the resistance of the wood to crushing and the resistance of the nail to bending, the resistance for different sizes varies somewhere between the variation of the diameters and the cube of the diameters of the nails. This variation corresponds quite closely with the square of the diameter of the nails.

The tests made show that further tests made with a wider range of variables are desirable and should include timber rough as well as finished and green as well as seasoned; nails covered with pitch; barb nails and finishing nails, etc. The tests might well include the effect of the falling load as well as one evenly applied and the effect of a load remaining in place for some time.

Tests of Fire Resistive Properties of Concrete.—Comparative results of tests of the heat insulating properties of materials used in fire resistive construction were given by Mr. W. A. Hull in a paper presented at the last annual meeting of the American Society for Testing Materials. The tests showed that the concretes from gravel and from boiler refuse from bituminous coal heated through most rapidly. Trap rock and blast-furnace concretes heated through more slowly, while the limestone concretes heated through most slowly of all, due in part at least to the thermal effect of dissociation of $CaCO_3$ in a thin layer next the surface. Gravel concretes gave particularly unfavorable indications and it was concluded that there was strong evidence that some gravels, at any rate, are distinctly inferior for concrete for fire-resistive construction. It was concluded also that cinder concretes are apparently to be viewed with suspicion, especially if the cinders contain much combustible material, which is apt to be the case with cinders from bituminous coal.

Stone Production in 1916.—The value of the stone produced in the United States in 1916 was $79,041,699, as reported to G. F. Loughlin, of the U. S. Geological Survey, Department of the Interior, an increase of nearly 6 per cent over the value for 1915. Of the total value over 52 per cent, or $41,319,871, was represented by limestone, an increase of more than 17 per cent over the value for 1915. Marble, valued at $7,033,171, representing nearly 9 per cent of the total, was the only other kind of stone that showed an increase (about 2 per cent). Of the other kinds, granite was valued at $17,418,582, basalt and related rocks at $7,666,297, and sandstone at $5,603,778, representing respectively 22 per cent, 10 per cent, and 7 per cent of the production, and decreases of about 3 per cent, 10 per cent, and 8 per cent of the values as compared with 1915.

A Simple Method of Designing a Double Reinforced Concrete Beam

By W. S. WOLFE,

Instructor in Architectural Engineering, University of Illinois.

The following method of designing double reinforced concrete beams has been found very convenient. Consider the following problem:

M = 1,600,000 in. lb.
Max. allowable b = 16 in.
Max. allowable depth = 26½ in.
Max. allowable fc = 650 lb. per sq. in.
Max. allowable fs = 16,000 lb. per sq. in.

Figure 1 shows a cross section of the beam; and it is desired to find the proper amount of tension steel, As, and also the proper amount of compression steel, A's. Draw Fig. 2; triangles, F B E, and, A B C, are similar, and for the given stresses the neutral axis is found by proportion to be 9.1 in. below the top of the beam. The compression steel is therefore 7.1 in. above the neutral axis, and by proportion the stress in the concrete at this distance above the neutral axis is found to be 507 lb. per square inch. First consider a beam of the given size reinforced for tension only and see how much moment it will carry.

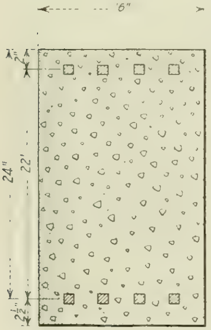


Fig. 1.

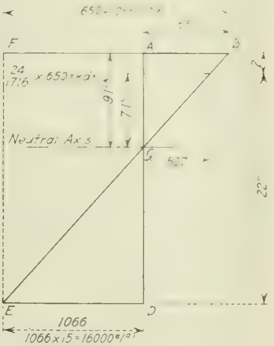


Fig. 2.

Moment = Rbd^2

Steel area = b d p.

From common tables or diagrams, R for the given stresses is found to be about 107, and p about .0077.

Moment = 107 × 16 × 24^2 = 988,000 in. lbs.

Steel Area = 16 × 24 × .0077 = 2.96 sq. in.

1,600,000 — 988,000 = 612,000 in. lbs. = remaining moment.

The remaining moment must be carried by additional steel, tension steel, and compression steel acting together to form a couple the arm of which is 22 in.

Additional tension steel area = 27,800 ÷ 16,000 = 1.74.

As = 1.74 + 2.96 = 4.70 sq. in.

A's = 27,800 ÷ (507 × 14) = 3.92 sq. in.

The value 14 is used in place of 15 because the compression steel has displaced some of the compression concrete. The stress in the compression steel is 507 × 15 = 7,600 lb. per square inch.

Production and Consumption of Building Material

Interesting statistics on the production and consumption of various materials used in general building and construction are given in a recent bulletin of the U. S. Department of Agriculture. The report was prepared by Rolf Thelen, Engineer on Forest Production, and is issued as a contribution of the U. S. Forest Service. The following notes are abstracted from the bulletin.

The five principal building materials used in the United States are lumber, concrete, steel, brick and clay products other than brick. The competition of these materials, following rapidly changing demands as well as rapidly changing conception of their utility, has undergone a remarkable change during the last few decades. The change has resulted from several economic factors, chief of which are: the effect upon rural construction of the gradual settlement of agricultural regions; the movement of population from country to city, building codes in urban construction, and, finally, comparative utility and cost.

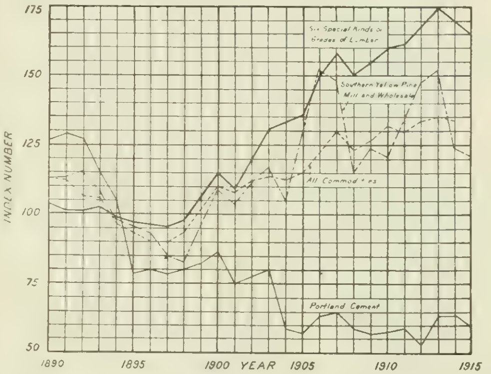


Fig. 1—Index Numbers of Wholesale Prices: Lumber, Portland Cement, All Commodities.

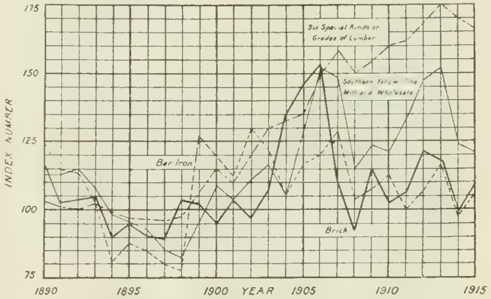


Fig. 2—Index Numbers of Wholesale Prices: Lumber, Bar Iron, Brick.

Comparative Cost of Materials.

Cost, equally with service or utility, may determine the ultimate use of competing materials. Satisfactory comparative costs of final structures made of different materials are difficult to obtain. Wholesale prices of these materials are much simpler and will answer the purpose of this discussion practically as well. The relative prices, or index numbers, shown in Figs. 1

and 2 for lumber, brick, bar iron, Portland cement, and "all commodities," for 1890 to 1914 or 1915, inclusive, are, with the exception of the yellow-pine mill and wholesale prices, based largely upon data taken from the publications of the Bureau of Labor Statistics, Department of Labor.

The six special grades or kinds of lumber are hemlock, poplar, spruce, yellow pine, maple and white oak. The Bureau of Labor Statistics prices, on which the curve for these species is based, are taken from quotations in the New York Lumber Trade Journal. Base prices are used for hemlock and spruce, and prices for one or two selected grades of poplar, yellow pine, maple and oak. The average mill and wholesale price of southern pine is based upon mill prices, which are also largely wholesale prices. They were obtained by the Forest Service. The brick is common red domestic, the bar iron, "best refined" from the Philadelphia market; and the Portland cement domestic. The "all commodities" curve represents the unweighted arithmetical average index price of the 252 commodities on which the Bureau of Labor statistics secured data. It indicates the actual trend of wholesale prices in the United States. Prices are made comparable by indexes. An average of the prices of any commodity from 1890 to 1899 represents the normal price of 100 per cent in the commodity curve. The price for each year is then calculated as a percentage of the normal price and so expressed. For the normal price of cement, the Bureau of Labor statistics data for 1895-1899 were supplemented by prices constructed from United States Geological Survey statistics. Prices of structural steel shapes comparable with the others used in Figs. 1 and 2 were not available, and those for bar iron are given as representing the best substitute. Prices could not be obtained for clay building tile, but are understood to have varied only slightly in the last two decades.

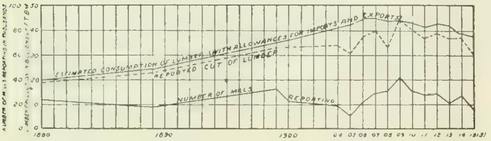


Fig. 3—Lumber Consumption in United States and Number of Mills Reporting Production.

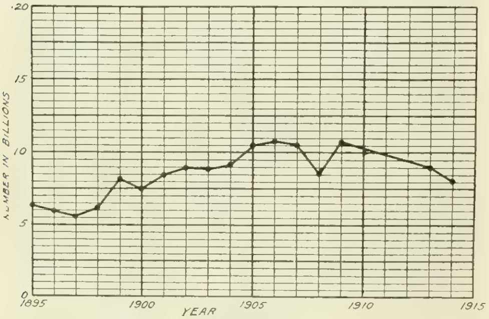


Fig. 4—Consumption of Building Brick in United States.

Neither of the lumber curves presents an entirely fair picture of the wholesale price situation. That for the six kinds of lumber is made up largely of species and grades in which prices for various reasons have been above the average and the volume of material sold comparatively small. The average mill and wholesale price for yellow pine is a mill price which includes a large number of sales direct to retailers. It includes selling costs, but is not a truly representative wholesale price because it does not include freight rates from the mill to the retail yard. The yellow pine prices are representative of material which forms the great bulk of the lumber cut.

The true wholesale lumber price curve falls between the two given. A general though not regular increase in lumber prices is shown for the 25-year period covered. A broad study of the situation indicates that the increase in lumber prices until 1907 was more rapid than the average for all commodities; since then the increase, if any, has been less rapid than the average. For the period shown, the general tendency has been toward increasing prices for lumber and decreasing prices for its competitors. Exact percentages cannot be given in the case of lumber; but between 1890 and 1915 common red domestic brick prices fell 7 per cent, bar iron prices 15 per cent, and cement prices 54 per cent. A more or less regular increase in lumber prices and a drop in cement prices of 54 per cent during the same period, coincident with the development of the cement industry, are indicative of one set of economic conditions which have made possible the very active competition of cement and its products with wood.

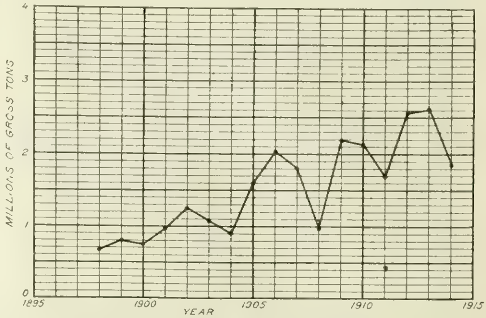


Fig. 5—Consumption of Iron and Steel Structural Shapes in United States.

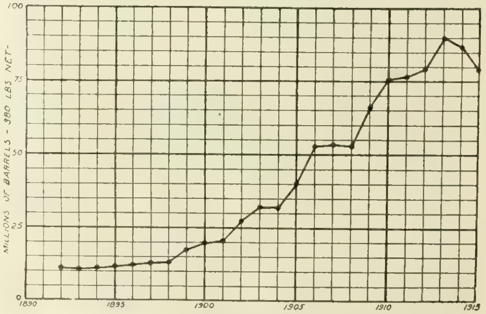


Fig. 6—Consumption of Natural and Portland Cement in the United States.

Incidentally, the curve of brick prices is of interest when studied in connection with Fig. 4, showing the consumption of building brick in the United States. With the exception of the peak during the years from

1904 to 1906, the price of brick has been very steady, whereas the consumption has varied widely. The point of highest price corresponds to one of the two points of greatest production, and the other point of maximum output corresponds with a minor peak in the price curve during the unusually prosperous year of 1909. There appears to be a direct relation between exceptional volume of demand and marked increases in price.

Production and Consumption.

The total estimated lumber consumption in the United States is shown in Fig. 3. This is one of the best indexes available of the changing use of wood in building and construction. Curves giving the number of mills reporting and their reported cut of lumber are shown to indicate graphically as far as possible the basis for the estimates of total consumption. These estimates, except that for 1909, for which a very complete census was taken, represent the consensus of opinion of a number of men familiar with the records of lumber cut for a number of years and the conditions in the industry. Allowances were made for exports and imports. The number of mills reporting varies to a considerable degree with the character of the census and is not necessarily an indication of the number of mills in operation during any year. Ordinarily, however, the bulk of the mills not reporting were of small capacity and did not materially influence the total cut.

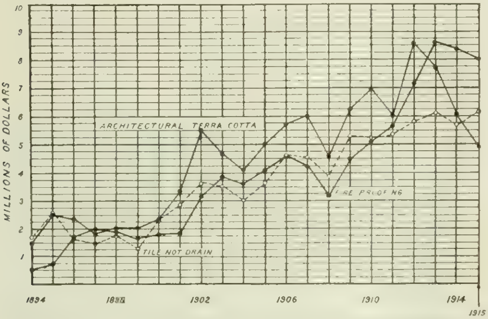


Fig. 7—Value of Production of Clay Building Materials in United States.

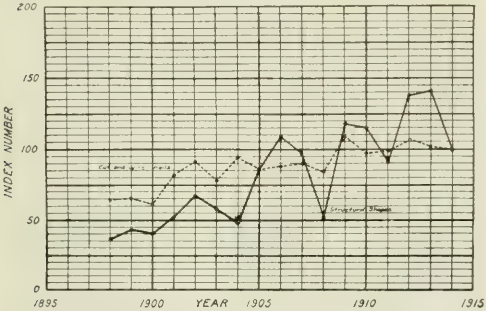


Fig. 8—Index Numbers of Consumption of Cut and Wire Nails and Structural Shapes in the United States.

The consumption of building brick in the United States as shown in Fig. 4 has apparently fallen off about 27 per cent since 1909. The total is made up of common and front clay brick, common front and finish sand-lime brick, and sand-lime blocks. Sand-lime brick represent about 2 per cent of the total consumption.

Evening out violent fluctuations, the consumption of iron and steel structural shapes, practically all of which are eventually used in buildings and bridges, has on the whole, as shown in Fig. 5, increased rapidly from 1898 to 1913. This increase was 285 per cent to 1913, and 174 per cent to 1914, an off year. The consumption of steel during 1906-7, the years of maximum lumber consumption, and 1914 are nearly identical, in spite of the fact that the general trend for steel is upward, while it is downward for lumber.

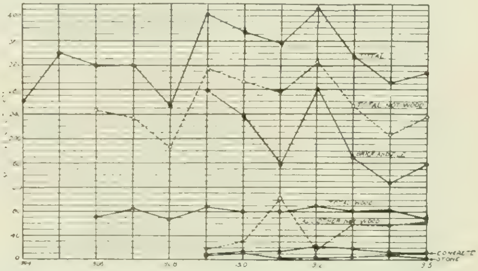


Fig. 9—Value of Building Permits Issued in 20 Cites of United States.

Natural cement was still popular 30 to 35 years ago when the Portland cement industry was in its infancy. Most of the present production in the United States, however, as is shown in Fig. 6, is Portland cement. Between 1907 and 1915, while the total lumber consumption fell off approximately 15 per cent, cement consumption increased 48 per cent. The cement consumption curve shows a rapid and practically unbroken increase, and in this respect differs from the curves for all of the other principal construction materials.

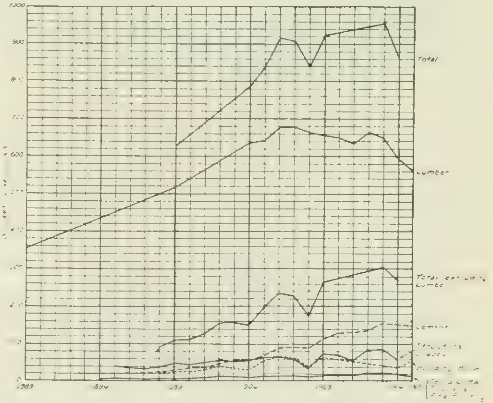


Fig. 10—Values of Principal Materials Used in Building Construction.

The value of various clay building materials produced in the United States is shown in Fig. 7. "Tile not drain" includes floor tile, wall tile, roofing tile, and faience, or art tile. The proportionate output of the various products is indicated for the year 1913 by the following valuations: Floor tile, $2,483,082; wall tile, $1,763,992; roofing tile, $1,130,286; faience, $731,820. Evening off rather violent fluctuations, production of all the clay products has increased rapidly since 1899. From 1907 to 1915 the general increase has been about 20 per cent. Further evidence on the relative consumption of iron and steel shapes and lumber in building construction is presented in Fig. 8 showing the consumption of steel shapes and cut wire nails on a basis made comparable by indexes. The consumption in 1914 has been taken as the base, or 100 per cent, for both curves. Percentages for other years are then determined by comparing the consumption during the year with that of 1914. If the consumption of nails is a good general indication of the use of lumber in building and construction, as is sometimes assumed, the curve indicates that there was a steady increase from 1898 to 1909, and since that time a falling off amounting to approximately 20 per cent. The use of structural shapes, although erratic, has in general increased rapidly.

The peaks and depressions in the various production curves are an excellent index of the general financial conditions in the country during the period covered. Thus in 1908 all of the materials, except cement, suffered a sharp decline and cement showed a small rate of increase. Since 1893 the production of cement has fallen off only in 1914 and 1915, whereas all of the other materials, notably steel, have shown sharp declines from time to time.

Building Permits.

From data published by the United States Geological Survey in its annual report on the mineral resources of the United States, curves have been constructed, Fig. 9, showing the value of the building permits issued in 20 cities, by classes. The classes are wood, brick, stone, concrete and all other not wood. The last includes steel-skeleton construction. Veneer and stucco buildings are included under wood. An estimate of the extent to which stucco has replaced wooden siding has, however, been obtained in another way and is given later. The 20 cities are: Atlanta, Ga.; Boston, Mass.; Cleveland, Ohio; Grand Rapids, Mich.; Hartford, Conn.; Indianapolis, Ind.; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Lowell, Mass.; Milwaukee, Wis.; New York, N. Y.; Philadelphia, Pa.; Richmond, Va.; Rochester, N. Y.; San Francisco, Cal.; Scranton, Pa.; Seattle, Wash.; Syracuse, N. Y.; and Washington, D. C. With a few minor exceptions, the data from all of these cities are exactly comparable, and these exceptions have practically no effect upon the final curves. Unfortunately, it is not possible to subdivide the "not-wood" curve into its components for the years 1906-1908, inclusive.

The depression in all of the curves for 1908 is very marked. It corresponds to similar depressions in the building material curves. The lesser depression in 1911 is also reflected in practically all classes of building permits. Lumber, so far as town construction is concerned, is shown to be the most stable of all the building materials. General financial conditions are first reflected in the permits for brick and tile buildings and last in wooden buildings. In other words, the construction of wooden buildings in towns tends to follow the even tenor of its way irrespective of panics and financial depressions. This is undoubtedly due to the larger proportion of small residences built of wood, the demand for which is less dependent upon the financial barometer. The total wood curve has been practically uniform since 1906-7. This curve does not, however, indicate the substitution of stucco for wooden siding, which may amount to as much as 13 per cent; and also does not indicate the amounts absorbed by the general increase in labor costs in the building trades, which account for from 5 to 15 per cent of the value of the 1913 permits.

Summary.

Lumber consumption in the United States reached its maximum in 1907 and has since fallen off approximately 15 per cent. During the same period the use of lumber in general building and construction has probably fallen from 32 to 27 billion feet, or about 5 billion feet. Brick is the only competing material whose consumption has fallen off. Though the consumption of iron and steel structural shapes was nearly identical in 1906-7 and in 1914, an off year, the general trend of the steel curve is upward, while that of lumber is downward. The general increase in steel consumption was probably about 45 per cent between 1907 and 1914, and the rise in the curve from 1900 to 1907 was similar to that from 1907 to the present. The increase in cement consumption from 1907 to 1915 is 48 per cent and that from 1900, 290 per cent. The increased consumption of clay building products during the same periods was 20 per cent and 170 per cent, respectively. The use of nails, which reached its highest point in 1909, indicates that lumber consumption in building construction has since fallen off 20 per cent. Building permits in 20 cities, considering the increase in labor costs and the substitution of stucco for wooden siding, indicate a falling off in the construction of wooden buildings.

Data for the entire country on the building situation as a whole are unavailable. There are obvious difficulties in reducing to a common structural unit, as a basis for comparison, such different materials as lumber, cement, structural steel and brick and other clay building products; and this is made still more difficult by the innumerable forms of use in building construction. An approximation of the general situation may, however, be obtained from a consideration of the total values of the principal construction materials, as shown in Fig. 10. Lumber values were obtained by applying a 10-year average mill price, $14.74, to the total estimated production as given in Fig. 3; cement values, by using a 20-year, 1895-1914, average mill price of $1.72 obtained from the Bureau of Labor Statistics, with the production of cement shown in Fig. 6; structural steel values, by using the Bureau of Census mill value of $33 averaged for 1909, 1904 and 1899, with the consumption data shown in Fig. 5; and building brick values by using a 17-year average price of $6.05 per 1,000 on red brick, taken from Bulletin 181, Bureau of Labor Statistics. For other clay building products it has been necessary to use the total value of the output as reported annually. While not directly comparable with the other curves this can have little influence on the results shown.

The percentage of the various materials which compete in general building and construction undoubtedly varies somewhat between materials and from year to year, so that the curves are not exactly comparable. It is believed, however, that the curves clearly indicate a rapid and fairly regular increase in building and construction as a whole up to 1913; and, further, that the increased consumption of building materials other than lumber was more than enough, after 1907, to offset the decline in lumber production and continue the increase in the total amount of building. In short, building and construction in the country seem to be increasing despite the fact that lumber, still by far the leading construction material in the value of its output, has been falling off since 1907.

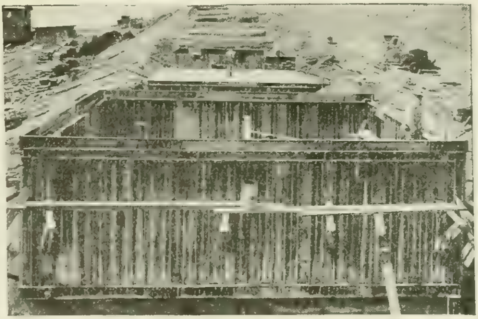
Building 100 Concrete Houses With Standardized Designs and Forms

A completed concrete house every three days is the record of production established by the Aberthaw Construction Co., Boston, Mass., in the erection of 100 concrete dwellings for the American Steel & Wire Co. at Donora, Pa. The houses are neat and attractive and of eight different styles, containing 4, 5 or 6 rooms, all with a bath and cellar. A few of the houses were erected in pairs with party walls, but the great majority of them are detached.

Partially Completed Houses.

The average floor area is about 26x26 ft., and the 6-room houses contain living room, dining room and kitchen on the lower floor and three chambers and a bath on the upper floor. All houses are of the box type with solid concrete walls 6 in. thick reinforced vertically on both faces and horizontally on the outer face with straight rods. The intermediate partition wall cuts down the floor spans to 12 or 15 ft. The floors are of the ribbed reinforced concrete type, with the ribs spanning between the outer and interior walls. In the cellar these ribs are left exposed, but on other floors plaster board is nailed to strips left in the concrete and a finish plaster coat is applied. The cornice is of reinforced concrete in which a gutter is formed.

On top of the concrete structure there is a roof of spruce framing covered with asbestos slate. Thus, with the exception of the roof frame, steps, window sashes and door frames the houses are non-combustible.



Foundation Work for Row of Concrete Houses.

Each house is equipped with gas, furnace and cooking range, electric lighting and with modern kitchen and bathroom equipment. Costs, including this equipment, ranged from $2,000 to $3,300 for each house. This price does not hold good under present market conditions.

Steel Forms Consisting of 9-In. Channels.

The fact that this work was undertaken and accomplished with such speed and satisfaction was due to the application of methods used on large buildings to the building of 100 individual establishments. The designs were thoroughly worked out in the first place,

Village of Standard Concrete Houses Erected at Donora, Pa., for Workmen of American Steel & Wire Co.

and standardized steel forms and wooden forms were used on successive rows of houses.

The steel forms are of the special channel type patented by the Lambie Concrete House Corporation, and consist of 9-in. channels which are set up vertically and are connected together with clips and wedges. A 4x4-in. steel angle is set up at the corner of the building and the forms are lined up longitudinally by a steel channel used to form a belt course. This not only fastens the forms of the lower floor but is bolted into the floor reinforcement and remains in place as a support for the second-story forms. It is removed after all the concrete has been poured.

The houses were constructed in groups, a set of forms being used for a group and then taken down as quickly as possible and used for the next group. Usually the forms were set up for 1-story wall and floor together, and then concrete was poured for this section all at one time. To complete 1-story takes about 7 days and working at this rate a house of two floors and a cellar is completely concreted in three weeks, and with twelve sets of forms the same number of form houses are completed in this period. Subsequent to this, plumbing, heating, plastering, roofing and finishing must be completed requiring about 5 weeks more. Twelve houses were completed in the first eight weeks and twelve every three weeks thereafter.

The contract for these houses was taken over by the Aberthaw Construction Company from another contractor. The original contractor placed concrete from a high stationary tower with a chute. However, on account of the number of moves of the tower necessary to cover the whole housing area, and on account of the small amount of concrete poured per house, 125 cu. yd. on the average, the tower method proved inefficient and the cost per yard of concrete was quite high. This cost was further increased by the cost of tower erection and construction.

The Aberthaw Company substituted small Koehring mixers which were placed beside each house during the placing of the concrete Wheelbarrows containing the concrete were raised by a small hoist placed on each building.

More than 400,000,000 ft. of Southern pine (approximately 20,000 carloads) has been purchased by the government through the Southern Pine Emergency Bureau for the war needs of the nation here and abroad, according to figures submitted at a general meeting of lumbermen on Oct. 23. This is in addition to about 375,000,000 ft. of timbers being placed through the Bureau for the construction of 250 ships for the Government's wooden fleet.

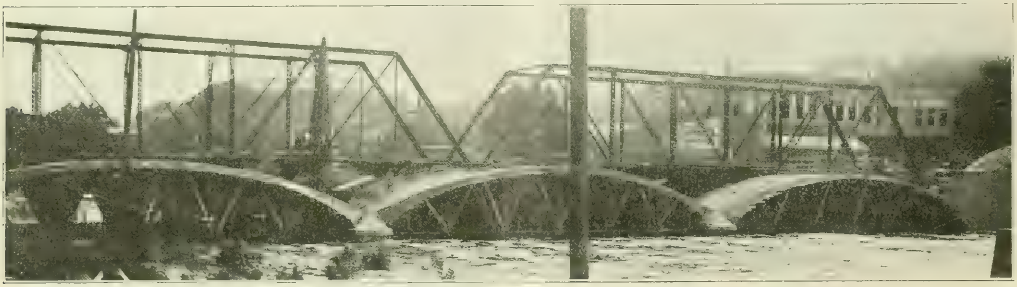
Old Steel Spans Used for Traffic and Working Platform During Construction of Arch Bridge Beneath

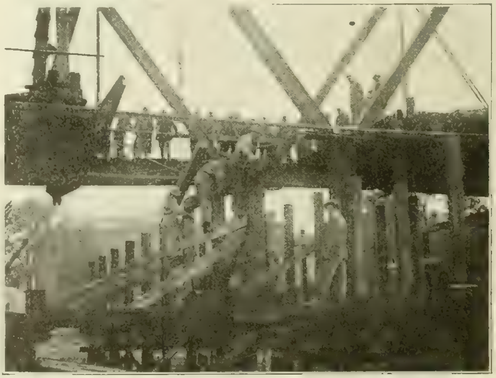
By R. W. GEARHART,

Highway Engineer, Buchanan County, Iowa.

Two steel spans of an old bridge at Independence, Iowa, were supported and used to maintain traffic and also as a working platform during the construction of a 3-span arch concrete bridge directly beneath it, which has recently been completed under the supervision of the writer.

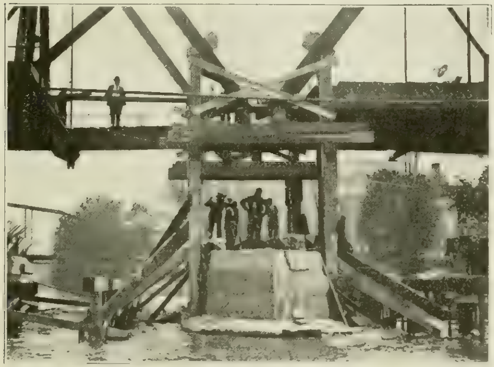
A clause in the contract required the maintenance of a foot bridge during construction. The contractor decided to support the old bridge in place rather than build a temporary foot bridge, as the course chosen made it possible to use the old bridge in placing the concrete and earth fill required for the new one. After the new bridge was done it was easy to dismantle the old steel spans on it without the necessity for falsework. The east abutment of the new bridge, which consists of three 80-ft. span arches, was located inside of the old abutment, but the west abutment was so located that the old abutment had to be removed. The west end of the west span of the steel bridge was therefore supported by a bent under each shoe, consisting of two 12x12 timbers and one 12-in. I-beam resting on timber posts. After the new abutment was completed, the weight of the span was transferred to two 10x24-in. timbers, one under each shoe, bearing


The Two Bridges With Arch Centering Still in Place.

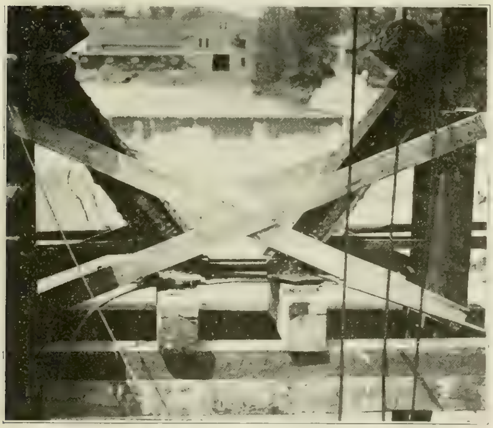

Placing False Work for Arch Centers.

directly on the new abutment. This support remained in place until the old steel was removed.

The east and west spans of the new bridge were concreted under the floor of the old bridge, there being 4-in. clearance between the top of the arch ring and the lower chord of the old bridge. It was necessary, however, to support the inside ends of the two steel spans, while the old pier was removed and the new center arch was constructed. The pins of the shoes of these spans were 2-ft. 11-in. apart. Three railroad rails were placed upon the pins as a supporting span to reduce the area occupied by the temporary support, so that the opening which had to be left in the arch ring could be made as small as possible. The opening left was 5-ft. 3-in. long and 1-ft. 6-in. wide. The shoes were first supported on timber bents while the old pier was removed, and then on 12x24-in. columns directly supporting the rails, as shown in one of the photographs. The reinforcing steel which passed through the opening was bent around the supporting columns in such a manner that the strength of the arch was not impaired after the columns were removed and the wedge shaped opening filled with concrete.



Supporting Old Spans While Pier Was Removed.



Old Spans Ready to be Shifted From Falsework to Supporting Columns.

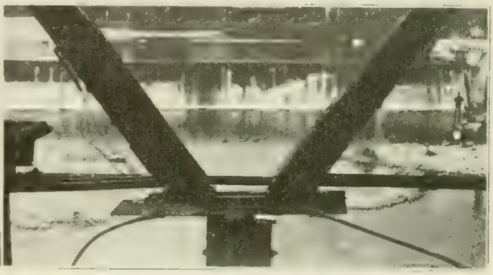
The Widell Co. of Mankato, Minn., was the contractor. The new bridge was designed by the Iowa Highway Commission.

Fills Versus Viaducts for City Streets

Interesting comparative costs of various types of structures proposed for erection in connection with special and rather unique street improvements of the city of Astoria, Ore., are given by Mr. Robert E. Cushman, in a paper in the September Journal of the Oregon Society of Engineers. The paper, practically in full, follows:

In order to improve sanitary conditions and to provide a substantial foundation for a modern and a permanent city, the tide flats over which the business district of Astoria was built on piles were filled in by means of a hydraulic fill pumped in from the river. The top of this fill is at a grade slightly above high water and on an average 9 ft. 6 in. below newly established street grade. The fact that a new street grade was established necessitated removing the old street system (trestle construction) and the construction of a new street, approximately 4 ft. 6 in. above the old grade; also all structures adjacent to the streets had to be raised a like amount. The final result was a basement space 9 ft. 6 in. in depth and street problems, as follows:

(1) To repair the old, badly depreciated wooden trestle with a new wooden trestle of the same type as the original.



Railroad Rails and Columns in Place as Support for Old Spans While Center Arch Was Turned.

(2) To fill in the streets with a sand or earth fill retained by walls, or with a natural slope extending onto the adjacent property.

(3) To construct a reinforced concrete viaduct, thus providing a utility subway.

(4) To construct a wooden viaduct surfaced with asphalt or bitulithic.

Plan No. 1 was given no consideration, as practically all property owners desired a more permanent and more sanitary street than would be provided by a wooden trestle. The average life of such a structure in Astoria in the past has been only about 8 years, and the cost to property owners has been close to $2 per foot of street per year.

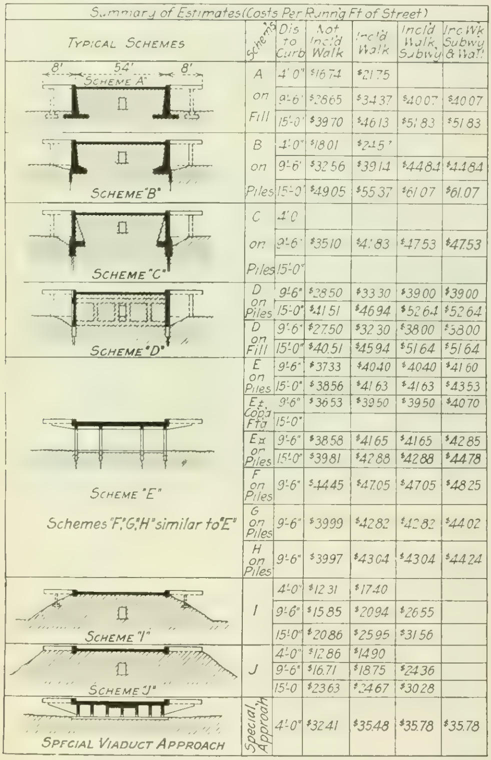
Engineering Statistics.

The average depth of fill in the case of Astoria is about 11 ft., and directly under this fill is a layer of about 20 ft. (average) of compressed silt, under which there is a strata of clay from 1 ft. to 9 ft. in depth, and under the clay there is a solid gravel stone formation, or compacted clay.

After this fill was placed, charts were kept recording the natural settlement for over a year. It was observed that a very marked settlement took place for many months after the fill had been placed.

Unit bearing tests were made in various sections of the city by the usual test platform method. The bearings were also flooded to duplicate the condition that would occur should the ground become flooded as in the case of fires. The records obtained indicated a safe bearing value of about one ton per square foot near the sea walls and 1½ to 2 tons per square foot near the inside edge of the fill.

Another very interesting bearing test was made as follows: A section of the main street of the city (Commercial St.) was cut free from the other trestle construction, and free from the piling. This section of street was then loaded with sand on a sub-platform under the street, and the whole structure was supported on grillage footings. This test platform purported to duplicate the condition of a concrete viaduct supported on footings. The average daily traffic over this platform was estimated to be at least 2,000 tons, consisting of 11-ton street cars, auto trucks and light vehicles. Loads on the footings (estimated) varied from 1,500 lb. to 2,400 lb. per square foot. The settlement at the end of one month after the beginning of the test varied from 19/32 in. to 1 9/16 in. under the various footings, and ultimately a settlement in excess of 3 in. was recorded for the footing carrying the maximum load, with no indications that settlement had ceased. Comparison with the settlement readings for test platforms carrying static loads showed conclusively that impact was the cause of the excess settlement under street traffic. The very nature of the wooden platform tested was such that the whole structure could not act as a unit, hence the effect of impact was not spread out, but was isolated and acted independently over each individual post.



Summary of Estimates (Costs Per Running Ft of Street)

Typical Schemes	Schem's	Dis to Curb	Not Incl'd Walk	Incl'd Walk	Incl'd Walk Subwy	Inc Wk Subwy & Wall
Scheme A	A on Fill	4' 0"	$1674	$2175		
		9'-6"	$2865	$3437	$4007	$4007
		15'-0"	$3970	$4613	$5183	$5183
Scheme "B"	B on Piles	4'-0"	$1801	$2157		
		9'-6"	$3256	$3914	$4484	$4484
		15'-0"	$4905	$5537	$6107	$61.07
Scheme "C"	C on Piles	4'0				
		9'-6"	$3510	$4183	$4753	$47.53
		15'-0"				
Scheme "D"	D on Piles	9'-6"	$2850	$3330	$3900	$3900
		15'-0"	$4151	$4694	$5264	$5264
	D on Fill	9'-6"	$2750	$3230	$3800	$3800
		15'-0"	$40.51	$4594	$5164	$5164
Scheme "E" Schemes "F," "G," "H" similar to "E"	E on Piles	9'-6"	$3733	$4040	$4040	$4160
		15'-0"	$3856	$4163	$4163	$4353
	E± Comp'd Ftg	9'-6"	$3653	$3950	$3950	$4070
		15'-0"				
	E¤ on Piles	9'-6"	$3858	$4165	$4165	$4285
		15'-0"	$3981	$4288	$4288	$4478
	F on Piles	9'-6"	$4445	$4705	$4705	$4825
	G on Piles	9'-6"	$3999	$4282	$4282	$4402
	H on Piles	9'-6"	$3997	$4304	$4304	$4424
Scheme "I"	I	4'-0"	$1231	$1740		
		9'-6"	$1585	$2094	$2655	
		15'-0"	$2086	$2595	$3156	
Scheme "J"	J	4'-0"	$1286	$1490		
		9'-6"	$16.71	$1875	$2436	
		15'-0	$2363	$2467	$3028	
Special Viaduct Approach	Special Approach	4'-0"	$3241	$35.48	$35.78	$35.78

Note:- For additional fire protection a 3" tile wall is included in viaduct figures. ± Compound footing consists of a footing so designed that fill takes a portion of load. ¤ Includes additional cost to provide for future car track (40 ton cars.)

Summary of Estimates for Typical Schemes.

The general data used in designs were as follows:

For Retaining Walls: (Concrete 1:2:4 mix.)
  Equivalent fluid pressure, 30 lb. per cu. ft.
  (Rankin's formula was not used.)
  Equivalent surcharge, 5 ft.
  Weight of fill, 100 lb. per cu. ft.
  Weight of concrete, 150 lb. per cu. ft.
  Sidewalk live load, 250 lb. per sq. ft.
  Stress in steel (tension), 16,000 lb. per sq. in.
  Stress in concrete (compression), 650 lb. per sq. in.
  Coeff. of friction, .67.
For Concrete Viaducts: (Concrete 1:2:4 mix.)
  Weight of concrete, 150 lb. per cu. ft.
  Street live load, 20-ton motor trucks passing in pairs.
  Sidewalk live load, 150 lb. per sq. ft. (wood walks).
  Roadway (impact) was figured by the formula.

$$I = \frac{L^2}{L+D}$$

D = Dead load moment. I = Moment due to impact. L = Live load moment.

Stress in steel (tension), 13,000 lb. per sq. in.
Stress in concrete (compression), 650 lb. per sq. in.
Stress in longitudinal column steel, 10,500 lb. per sq. in.
Stress in spiral steel (equivalent), 16,000 lb. per sq. in.
Stress in core of column, 650 lb. per sq. in.
No impact was figured in designing columns or footings.

Where pile foundations were figured sufficient data were available from past soundings and other pile-driving records to determine the approximate length of piles required in various sections of the city. Bearing on piles was to have been figured by the formula

$$L = \frac{2WH}{S+I}$$

where L = safe load in tons, (h) equals fall of hammer in feet, (w) equals weight of hammer in tons, and (s) equals penetration in inches under last blow. Limiting load 25 tons.

Wooden Viaducts:
  Street live load, 15-ton trucks passing in pairs.
  Sidewalk live load, 250 lb. per sq. ft.
  Impact on the roadway was figured by the same formula as used for the concrete viaduct with an established limit of 100 per cent.
Limits Established:
  Extreme fibre stress for caps, stringers and decking, 1,600 lb. per sq. in.
  Compression on columns, 1,500 lb. per sq. in., modified by the common rules for length to least dimension. Deflection was also considered and was limited to 1/360 of the span.
Treatment of Timbers:
  Sills, 8 lb. creosote treatment.
  Posts, 6 lb. creosote treatment.
  Decking, 8 lb. creosote treatment.
  Stringers, caps and bracing, no treatment.

Cost Statistics.

Comparative estimated costs of different classes of construction proposed are shown in Fig. 1. Types of construction shown are:

A. Cantilever walls at curb (no piles).
B. Cantilever walls at curb supported on piles.
C. Counterforted walls at curb supported on piles.
D. Flat slabs at curb with ties across street. (Slab reinforced in two directions.)
E. F. G. Types of reinforced concrete viaduct.
H. Fill (not retained). Shoulder at curb.
I. Fill (not retained). Shoulder at property line.

The unit costs upon which the table in Fig. 1 was based are as of Nov. 1, 1915.

  Cement, $2 per barrel.
  Sand, $1.30 per yard.
  Stone, $1.50 per yard.
  Hydrated lime, $13 per ton.
  Water, ½ ct. per cu. yd. concrete.
  Steel, $52 per ton, f. o. b. Portland.
  Mixing, wheeling and placing concrete, 85 ct. per yd. concrete.
Forms:
  For floor slabs, 4 ct. per sq. ft. surface contact.
  For floor beams, 4½ ct. per sq. ft. surface contact.
  For columns, 4 ct. per sq. ft. surface contact.
  For cantilever walls, 3 ct. per sq. ft. surface contact.
  For counterforted walls, 5 ct. per sq. ft. surface contact.
Labor:
  Fabricating and placing steel for slabs, $10 per ton.
  Fabricating and placing steel for columns, $17 per ton.
  Piles in place, 16 ct. per foot.
  Cost of removing old trestle was figured at $1.25 per running foot of street.
  Fill between concrete walls, 19 ct. per cu. ft.
  Fill with natural slope onto property, 25 ct. per cu. ft.

Relative to fill, it should be noted that for a hydraulic sand fill a submerged pipeline 1,700 ft. in length across the channel would have been necessary, and, in all, over 5,000 ft. of pipeline. As the company that placed the original fill had a submerged pipeline in place, competition for this type of fill was eliminated on account of the prohibitive cost of a new submerged pipeline to a competing company; in addition, material on hillsides was of a nature that could not be readily sluiced, so that form of fill could not be considered.

Material prices were changed to conform to prices as of date of which bids were called for.

Overhead costs were also revised on final estimates, which revision was occasioned by a more detailed knowledge of conditions to be encountered on the work and methods of making payments. (By ordinance no extras were allowed and no estimates could be paid during course of construction.) This revision should properly be applied to figures given in Fig. 1.

Comparison of Overheads:	
November, 1915	18.0%
	Of labor and material.
March, 1916:	
Temporary sheds, runways, supervision, timekeeper, watchmen, phone service, liability insurance and bond	6.8%
Contingencies and traffic delays	3.0%
Interest during construction	4.4%
Profit	11.4%
Total	25.6%
Percentage used	25.0%

The unit costs for creosoted wood viaduct on which estimated costs were based are:

Removal of old street, $1.50 per foot of street.
Excavation of backfill, 40 ct. per cu. yd.
Sills, 8-lb. treatment, $40 per M. ft. in place.
Posts, 6-lb. treatment, $35 per M. ft. in place
Stringers (not treated), $22 per M. ft. in place.
Creosoted decking, 8-lb. treatment, $40 per M. ft. in place.
Bracing (not treated), $24 per M. ft. in place.
Pavement, $4.50 per lin. ft. of street.
Curb, 80 ct. per lin. ft. of street.
Sidewalk stringers, $21 per M. ft. in place.
Sidewalk decking, $24 per M. ft. in place.
Concrete surface on walk, 9 ct. per sq. ft.

The cost of creosoting timbers as included in above units was figured at $15 per M ft. B. M. for 6-lb. treatment and $18 per M ft. B. M. on an 8-lb. treatment, which figures it was estimated would be sufficient to cover delivery.

Overhead costs and profit were included in this case in the units.

The probable comparative accuracy of the estimates is substantiated by the bids on the types of improvement for which bids were called. Comparisons are as follows:

Street improvement involving Type "D" construction (concrete walks each side of street, tie rods across street):

Ninth St.:	
Bid	$13,206
Estimate	11,523

Concrete viaduct (wood walks, bitulithic surface on roadway and electric lights in subway).

Duane St.: (50 ft. wide, 550 ft. long):

		Per foot of street.
Bid	$24,399, or	$44.36
Estimates (per preceding units)		44.30
Estimate for typical 50-ft. street, by committee		48.18
Final estimate conforming to committee report	$26,520, or	48.22

Wooden Viaduct: (Concrete walks on wood base, bitulithic surface on roadways, no electric lights in subway).

Duane St.: (50 ft. wide, 500 ft. long).

		Per foot of street.
Bid	$12,364, or	$24.72
Estimate	13,400, or	26.80

Utility Statistics.

The utility problem was studied from several angles in order to estimate the true utility value to be credited to the viaduct. From a utility standpoint, some advantages of a viaduct system may be summed up as follows:

1. Accessible for additions to underground construction.

2. Accessible for removal and repairs of underground construction.

(Water mains, water connections, sewers, sewer connections, gas mains, gas connections, electrical conduits, electrical service connections, telephone conduit and service, fire alarm conduit, etc.)

3. Permits removal of unsightly overhead construction.

4. Opportunity for a central heating plant at a minimum cost.

(In some localities saving to utility companies by the construction of subway systems is capitalized and a rental charged for the use of such a subway on this basis.)

In a final comparison, many other factors than first cost and utility should be considered, as depreciation, cost of laying pavement, interference with traffic and business, percentage of money spent on improvement that would remain in the community, sanitation, danger from explosions in subways, danger of breaking existing sewer due to settlement in case of a new fill, etc. All of the above matters were analyzed in studying the Astoria case. Another consideration in the case of Astoria was the fact that the whole downtown water system should properly have been removed and replaced at this time in the case of filled streets.

Numerous legal questions, petitions and other outside influences were encountered in the Astoria problems which had considerable bearing on the methods of improvement actually adopted.

The wooden viaduct with a bitulithic surface and concrete walks on a wood base was constructed in the main business district of Astoria, Ore. The life of this structure, depending largely on a watertight street surface and on proper ventilation, will be the factors that will determine its comparative value. Several types of walls were constructed where the bearing was suitable for walls supported on the ground, and other streets were improved by a very special type of construction which embodied the fill retained by wooden walls, and removable reinforced concrete slab walks supported on piers.

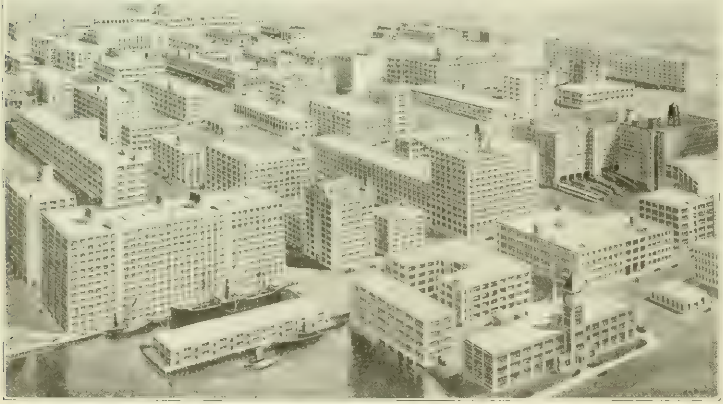
Gas to be Sold in New York City on Heat Unit Basis.—The Public Service Commission for the First District of New York has adopted an order providing a method by which the gas companies operating in New York City may change the standard under which gas is furnished from the 22 candle power basis, established by law, to a heat unit basis. The order, however, is tentative and will remain in effect only for the duration of the European war and for three months thereafter, at which time the companies will revert to the candle power basis unless the Commission in the meantime determines upon the heat unit standard as a permanent fixture. The order was issued at this time in order that the gas companies might begain providing the United States Government with certain gas residuals, notably toluol and other chemicals greatly needed in the manufacture of munitions. The order of the Commission provides that all companies operating under the order, in the event that the number of heat units per cubic foot of gas furnished to consumers is less than the average number now furnished under the candlepower standard, must make a corresponding discount in consumers' bills.

The plans adopted by the Federal Shipping Board contemplate a merchant marine fleet of approximately 2,100 ships by the close of the year 1919. These ships will have a dead weight tonnage of 14,500,000.

$9,000,000 Worth of Building Contracts in 1916 by One Contractor

The industrial city illustrated below represents the work of one construction company in the year 1916. The 70 buildings shown are located in various sections of the country from Cape Cod to Cleveland and from South Jersey north. The cut is reproduced from a drawing made to scale from actual photographs or from blue prints.

All the buildings are of reinforced concrete construction and are used for industrial purposes only. The approximate total value of the buildings is $9,000,000 and the number of different industries housed is 67. The structures cover an area of 4,376,000 sq. ft. In their construction 360,000 bbl. of cement and 25,000,000 lb. of reinforcing steel were used. The lumber used in the forms or falsework amounted to 8,615,000 ft. B. M. The maximum number of men employed by the contractor at any one time was 4,190, and the maximum number on any one building was 450.



One Year's Work of a Construction Company.

The average speed in erection was 4 stories in 18 weeks. The speed record was made on building No. 27, which is approximately 500 ft. by 100 ft. in plan, 8 stories high, and was built in two sections. The building including walls, windows, floors and roof, or 16 stories (required by the two sections), was completed in 80 working days, or one story every 5 working days.

The 70 buildings were erected by the Turner Construction Co., New York.

Granite Production in 1916.—The granite produced in the United States in 1916 was valued at $17,418,582, 22 per cent of the value of the entire stone output, according to reports of producers to G. F. Loughlin, of the U. S. Geological Survey, Department of the Interior. This was a decrease of nearly 3 per cent compared with 1915 and was the lowest recorded production since 1914. Of the total value, $4,305,517 was for rough and dressed building stone.

Notes on Prepared Paints for Metal Surfaces*

In designing protective coatings for metal the modern practice has been to apply the results available from researches into the cause of corrosion. These results have shown that materials of a basic nature or substances which contain soluble chromates prevent the rusting of iron. For this reason pigments of a basic nature or pigments containing the chromatic radical have come into wide use in the manufacture of protective paints. That they are the best pigments for this purpose has been proved not only in practice, but also in the Atlantic City tests, which were made upon a series of 300 large steel panels, using nearly one hundred different pigment paints. Applying the results of these tests to the practical manufacture of protective coatings, the writer will discuss the use of the various pigments under separate headings, taking up the composition of the most widely used colors for metal painting, namely, red, gray, black and green. Most of the paints outlined herewith are suitable for the painting of structural steel, bridges, steel railroad cars and equipment, ornamental iron work, poles, posts and for general work on metal surfaces.

Red Lead Priming Paints. Red lead may be purchased in the market ground to a heavy paste in linseed oil, ready to thin with oil for use. Such red lead is usually produced by the thorough oxidation or overburning of lead, the dry pigment generally containing approximately 98 per cent of lead tetroxide. This pigment, being practically free from litharge, does not react to any great extent upon the linseed oil in which it is ground, and therefore remains soft for a considerable period of time. It is well understood, however, that one of the most valuable properties of red lead is its ability to set up to a hard, elastic film that shuts out moisture and gases which are apt to cause corrosion. This cementing action is due to the presence of unburnt litharge, a pigment which rapidly reacts upon linseed oil to form a lead linoleate compound. It will readily be seen, therefore, that red lead free from litharge has no cementing action and should not be considered more protective than iron oxide or any other similar neutral pigment. It is thoroughly essential that red lead should be highly basic and should contain a considerable percentage of litharge, if the red lead is to protect iron from corrosion. Although such red lead is often purchased in the dry form and mixed with linseed oil on the job at the time of application, it is a growing custom to use prepared red-lead paints made from finely divided red lead ground to a fluid condition in linseed oil. Such paints remain in excellent condition for a long period of time.

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*From a paper by Henry A. Gardner, Assistant Director of Institute of Industrial Research, Inc., in the August Bulletin of the Affiliated Engineering Societies of Minnesota.

They have a high protective value and are well suited for general purposes. They are used extensively for priming steel vessels. The Navy Department has found that inert pigments, such as silica and asbestine, give good results when used in ready mixed red-lead paints, their action being to prevent settling of the red lead upon storage.

A specification which may be used by the grinder when purchasing dry red lead for the manufacture of prepared paints is given below:

1 The dry pigment to be of the best quality, free from all adulterants, and to contain not less than 85 per cent nor more than 90 per cent Pb_3O_4, the remainder being practically pure lead monoxide (FbO).

2. It shall contain not more than 0.1 per cent of metallic lead nor more than 0.1 per cent of alkali figured as Na_2O

3. It shall be of such fineness that not more than 0.5 per cent remains after washing with water through a No. 21 silk bolting-cloth sieve.

Note.—If desired, the gram weight of the red lead may be specified. Extremely light, fluffy red lead should run from 10 to 13 grams per cubic inch. Medium red lead will run from 13 to 16 grams per cubic inch. Heavy red lead will run from 17 to 19 grams per cubic inch.

Composition of Red-Lead Priming Paints.—The cost of red-lead paints is a subject of vital importance to the large user. Red lead may be produced in different physical states. Ordinarily the grade that has been overburned is extremely heavy, 1 cu. in. weighing from 18 to 20 grams. For the production of a paint from such red lead, according to the formula used by one large consumer, the following quantities would be required:

Red lead	26 lb.
Linseed oil	26 gills
Petroleum spirits	3 gills
Drier	3 gills

This would produce approximately 1 2/5 gal. of paint. Each gallon would contain about 20 lb. of red lead. A red lead of a much better protective value, containing from 10 per cent to 12 per cent of free litharge and produced in an extremely fine physical state of comminution, so that 1 cu. in. would not weigh over 12 to 15 grams, would produce a paint of exactly the same body on the following formula:

Red lead	20 lb.
Raw linseed oil	25 gills
Turpentine	3 gills
Drier	3 gills

This would produce approximately 1 1/3 gal. of paint, each gallon of which would contain about 15 lb. of red lead. Red lead of still lighter gram weight could be used, so that a still smaller quantity of pigment would be required per gallon of oil. The durability of such paints should compare favorably with those containing very high percentages of red lead of high gram weight. Pigments of an extremely light nature, such as lampblack, grind in very large quantities of oil, yet their films are more elastic and durable than many paints which are composed of much pigment and little oil.

Red Paints.—Iron oxide has always been one of the most widely used pigments for the manufacture of protective coatings. Oxides that are free from acid or soluble substances give the best results. There are many grades, from the brilliant Indian reds, containing 98 per cent, down to the natural mined brown shale oxides, containing from 30 per cent to 60 per cent of ferric oxide, the balance being silica, clay, etc. Venetian reds, consisting of about equal parts of ferric oxide and calcium sulphate, are also quite widely used. It is customary to add to iron oxides from 10 per cent to 20 per cent of zinc chromate, zinc oxide, or red lead, in order to make them rust inhibitive. Such red paints are widely used for application to tin roofs, metal siding, and general structural steel. Red paints made from basic lead chromate (American vermilion), the pigment which gave the best results in the Atlantic City tests, would doubtless be the most economical in the long run, but the high cost will probably prevent their use to any great extent. The use of a percentage of basic chromate of lead in iron-oxide paints is to be approved.

Gray Paints.—Mixtures of white lead (basic carbonate or basic sulphate) and zinc oxide, tinted gray with carbon black, are widely used for this purpose and give excellent results in every climate.

A valuable rust-inhibitive coating for general priming or finishing work may be prepared from sublimed blue lead. The use of two parts of blue lead and one part of linseed oil containing about 5 per cent of turpentine drier makes a paint of the right consistency. This may be purchased in prepared form. When this paint is used for top-coat work in marine exposures (battleship gray), the addition of 1 per cent of carbon black to the blue lead aids in the maintenance of the color. The rust-inhibitive value of this pigment is due to the high percentage of lead oxide (litharge). This pigment, however, is so combined with the lead sulphate that it does not have any great hardening action upon the linseed oil and stays in an excellent condition in paste form for a long period of time without hardening. When purchased ground to a paste in 10 parts of oil, there should be added approximately 5 gal. of linseed oil and one pint of drier for use. A specification for the purchase of blue lead for use in metallic paints is given herewith:

	Minimum.	Maximum.
Lead sulphate	44%	52%
Lead oxide	33%	40%
Lead sulphide		0.5%
Lead sulphite		3.5%
Zinc oxide		3.0%

Black Paints.—Black paints are often preferred for the finishing coat on steel work, carbonaceous paints being unsuited for application direct to the metal on account of their rust-stimulative action. Carbon pigments, such as gas carbon black, oil black, artificial and natural graphite (flake and amorphous) are usually the base pigments used in black paints. Silica and other earth pigments may be combined with the carbon. The slow-drying nature of such paints is lessened by the addition of litharge. The use of boiled linseed oil as a vehicle is advisable.

Magnetic black oxide of iron (precipitated) forms an excellent black protective paint when ground in linseed oil. The slightly basic character of this pigment accounts for its inhibitive value. The natural variety of black magnetic oxide of iron is also suitable for this purpose, but should be tested for freedom from soluble acid impurities before use. Willow charcoal is not made in commercial quantity; its use, therefore, will be restricted. Its inhibitive value depends upon the basic nature of the impurities present.

Green Paints.—Mixtures of zinc chromate and Prussian blue in oil are highly inhibitive and have proved satisfactory in long service tests. Chrome yellow tinted with black oxide of iron to an olive shade is very permanent and protective. Chrome green made from lead chromate and Prussian blue is generally used when precipitated upon a barytes base.

Marine Paints.—Steel vessels traversing bodies of salt water are rapidly acted upon, corrosion and incrustation by marine growths being shown. The bottoms of boats are usually protected by applying over the red-lead priming paint a coat of anti-corrosive paint containing iron and zinc pigments ground in a shellac-alcohol vehicle. There is subsequently applied a coat of anti-fouling paint, usually made of iron oxide, zinc oxide and metallic zinc powder, admixed with a poisonous compound such as red oxide of mercury or bichloride of mercury. The upper portions of vessels are usually painted with a linseed-oil paint, the standard slate color of the Navy Department consisting of a mixture of white lead and zinc oxide tinted gray and ground in linseed oil. This is, of course, applied over a prime coating of prepared red lead. The boot topping or water-line paint is generally of a bituminous nature, the exposure at this point being extremely severe. Chinese wood-oil varnish improves the bitumen base.

Bituminous Paints.—Bituminous coatings have a wide use for special purposes. They are often made by blending refined coal-tar pitch, asphalt, linseed oil and oleo-resinous varnishes, subsequently thinning down the turpentine or light mineral thinner. During recent years a heavy-bodied blown petroleum residual pitch has come into wide use in the manufacture of waterproofing bituminous paints. This pitch usually has a high melting point (150° C.). It is soluble in turpentine, benzol, and some mineral distillates. When in solution it may be admixed with oils for the production of rapid-drying elastic paints. The pitch has high resistance to acids and is not acted upon by the sun to the extent that coal tar is.

When coal tar is used in the manufacture of paints, it should be refined. Ammonia and water in the tar are the active causes of saponification or non-adherence to metal. The presence of large quantities of free carbon or naphthalene in the tar will cause disintegration and checking. For refining, the crude tar may be heated to approximately 115° C., holding it at that temperature until the water is evaporated. From 5 per cent to 10 per cent of lime may be stirred in, in order to neutralize the free acids. The tar may then be thinned with benzol or mineral spirits. If a rapid-drying paint is desired, a quantity of resinous varnish may be added. The addition of Chinese wood oil and asbestine in a coal-tar paint made along the above lines will aid in producing a film that is not so subject to alligatoring when exposed to the sun.

Bituminous paints of the above composition are used as coatings upon pipe-lines in acid factories, tanks containing dilute acids, metal submerged in water, and for other similar work. For such purposes it is generally advisable to first coat the metal with a thoroughly hard drying prime coating made by adding 2 lb. of litharge to a prepared red lead or other rust-inhibitive paint. The bituminous paint may then be applied. Steel mine timbers subjected to sulphur water and gas, reservoir tanks containing water, submerged lock gates, tunnel metal, etc., may be efficiently preserved from corrosion by this method.

Painting Galvanized Iron.—Roofing, siding, railing, drain pipes, cornice work, etc., constructed of galvanized iron require painting if they are to be kept in a good state of preservation. Paints are apt to peel from galvanized iron on account of the smooth, spangled surface. This condition, however, is obviated by first treating the metal before painting with a solution of copper salts. Such a solution may be prepared by dissolving 4 oz. of copper acetate, copper chloride, or copper sulphate, in one gallon of water. By brushing on this solution the galvanized iron is roughened, a thin deposit of copper being plated out over the surface. After an hour or so, the surface may be lightly brushed and then painted with a thoroughly inhibitive oil paint. Firmly adhering films are thus produced.[†]

Painting Tinned Surfaces.—Tin plate, such as is used for roofing and siding, will rapidly corrode unless protected by paint. The pin-holes present in the tin coating on the steel base metal act as pockets to catch moisture, which causes rust spots and pit-holes. Before applying paint to the sheets it is advisable to rub the surface of the tin with a cotton rag saturated with benzine or turpentine. This will remove the palm oil that is present upon the surface and allow the paint to firmly adhere. Iron-oxide paints containing an inhibitive pigment are widely used for preserving tin. The use of 15 per cent to 20 per cent of zinc oxide, red lead, or zinc chromate with a neutral bright iron oxide produces an excellent paint. The partial use of boiled linseed oil or kauri gum mixing varnish will add to the gloss and water resistance. Such paints are also suited for use on metal shingles and pressed-steel siding—plain black, galvanized or tinned. For dipping purposes, turpentine or high boiling point mineral spirits should be used for thinning. Cheap driers containing a low boiling point benzine should be avoided.

More Efficient Use of Available Equipment by Railroads

According to an announcement on Oct. 22 of the Railroads' War Board on Oct. 1st the excess of unfilled orders from shippers for freight cars over and above the idle cars at different points numbered 70,380. This compares with the excess of unfilled car requisitions amounting to 77,682 on July 1st; 33,776 Aug. 1st; 34,605 on Sept. 1st. The actual number of unfilled car orders on Oct. 1st was almost identical with the number on Oct. 1st last year, the figures being 94,572 for Oct. 1, 1917, and 94,854 for Sept. 30, 1916. The difference in the excess of unfilled orders over idle cars for the two years is accounted for by the fact that on Sept. 30, 1916, as many as 34,157 cars were idle, whereas on Oct. 1, 1917, only 24,192 were reported as idle, thus indicating a more efficient use of the available equipment on the part of the railroads. Returns to the Railroads' War Board show that the actual number of cars and locomotives now in service on American railroads is only slightly in excess of the number at this time last year. The War Board on Oct. 10th had been in existence exactly six months and the returns just at hand show that during that period the railroads of the country have rendered upwards of 15 per cent more service than they did during the same period last year with practically the same plant.

The contract for the construction of an ordnance depot and arsenal which is to be established in France in connection with the overseas base for American forces has been awarded to a Boston firm. Payment for the work will be on the basis of cost plus 10 per cent. It is expected that the total expenditure will be well over $100,000,000. Lathes and other special machinery for the arsenal are already being delivered and the cost of this equipment alone is estimated at $6,000,000. The workmen necessary for constructing the depot will be transported from the United States and it is stated that not less than 10,000 have been listed for the purpose. All raw materials and machinery will be sent from America.

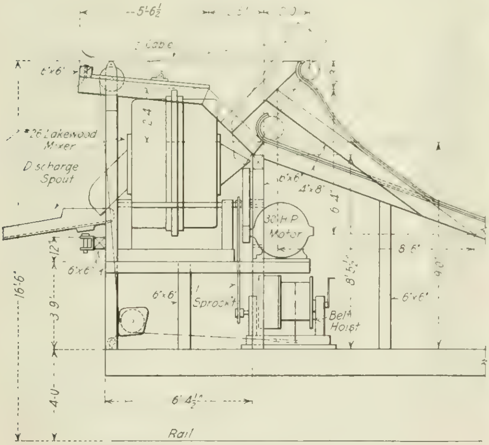
[†] The writer has recently experimented with solutions of metallic salts of arsenic, antimony, tin, lead, mercury, cobalt, iron and manganese to replace copper solutions for the above purpose. Arsenic and tin were most satisfactory, but not as economical or desirable as copper.

Labor Saving Car Plant for Concreting Station Platforms at Pennsylvania Terminal, Chicago

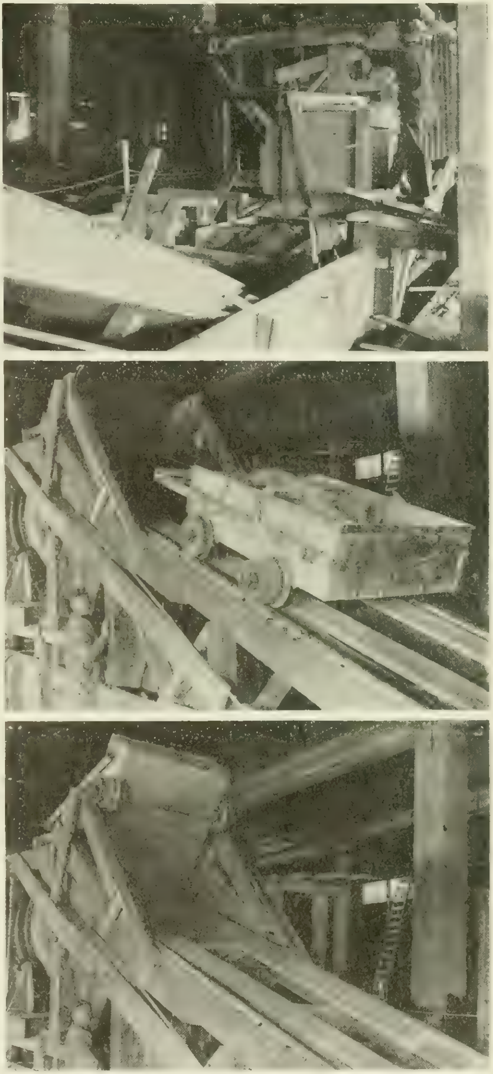
An ingenious method of furnishing material to a mixer with a minimum of labor when working in cramped quarters, is being employed in constructing the concrete track platforms in the basement of the partially completed freight station and warehouse of the Pennsylvania Lines at Chicago.

Down in the semi-darkness of the basement of this large new freight terminal there are eighteen concrete platforms to be poured, each 850 ft. long and varying in width from 8 ft. to 38 ft. The platforms have 5-in. concrete floor slabs supported on continuous concrete beams 12 in. thick resting on piers placed every 20 ft. The total yardage of concrete in same will approximate 10,000 cu. yds., distributed over an area of about 400,000 sq. ft.

The nineteen permanent stub tracks for the terminal are laid and over these tracks the contractor is operating a self-contained electric-driven mixing plant occupying two gondolas and a box-car. A ¾ yd. Lakewood mixer, 30 H.P. motor and a small belt hoist are mounted on the forward end of the first gondola with an inclined track running from the rear end of the car up to the charging hopper of the mixer. The second gondola supports a timber bin structure divided into compartments for 40 yds. of sand and 80 yds. of stone. This bin structure is hopper-shaped and has six bottom gates. A track is laid on the floor of the car and a flexible rail connection between the open ends of the gondolas links the track on the bin-car with the incline track leading up to the charging hopper of the mixer. The 40-cu. ft. skip-car which runs on this track is divided by swinging gates into compartments for the correct proportions of sand, stone and cement for one charge of the mixer. This car is pulled forward and hauled up the incline by a ½-in. cable running on the drum of a small hoist driven by belt from the shaft of the motor and empties its contents into the mixer hopper by the self-tilting arrangement shown in the lower of the three accompanying illustrations. When the hoist drum is released the skip runs back by gravity to its first loading point beneath the stone bin.



Arrangement of Mixer, Motor and Hoist.



Upper View: Skip Car Being Loaded with Cement. Middle View: Skip Car Ascending Incline. Bottom View: Skip Discharging Load in Mixer.

Behind the bin-car is a box-car providing storage for cement which is handled in bags, and wheeled from the box-car along a runway to a two-bag hopper built on the front of the bin-car, shown in the upper of the three accompanying views. Here a second laborer empties the cement into the hopper and later by raising a sliding gate spills the contents of the hopper into the skip car when it comes through with its load of sand and stone.

The men required to operate this plant are as follows: One man in cement car, one man at cement hopper, one man operating sand and stone bin gates, one engineer operating mixer and hoist which are driven from the one motor, and one man on front of mixer car who takes care of the water measuring tank and the mixer discharge chute.

With this arrangement, the mixer can be operated to its full capacity of 45 yds. an hour for about three hours. Then a switcher removes the emptied bin-car and brings in another bin-car filled with sand and stone, and after a few minutes' interruption the mixer starts up again on another three hours' run.

Current for the motor is obtained by running a wire across the middle of the building from the main feed wire, which also furnishes current for operating two tower mixing plants, four large elevator hoists, etc., At four equi-distant points on this cross-wire are slip connections for attaching a 450-ft. cable which carries the power to the motor on the mixer car.

The special equipment for this mixing plant was built by French & Allen for the O. W. Rosenthal Company, who have the contract for placing the concrete of entire building, a total of 60,000 cu. yds. A. S. Armstrong is the superintendent in charge of the work. The George A. Fuller Company has the general contract for the superstructure.

Misuse of the Word Engineer*

It is indeed unfortunate that in America most people associate the word "engineer" with a man in greasy overalls who runs an engine or a boiler. The man who operates the boilers of an apartment building is called an engineer, although, as we shall see in a moment, the name is entirely a misnomer when applied to him. He may be a good mechanic, but he is not an engineer. The gray-haired man who drives the locomotive of a transcontinental limited, and who holds the lives of hundreds of human beings in his care, belongs to the very highest type of mechanic; but he is not an engineer—except in the United States and Canada.

Much has been said and written on the importance of educating the public to the true meaning of the word "engineer." In this case, as in many others, it is of far greater importance that engineers themselves be educated to the true meaning. So long as engineers use the word improperly, how can they expect to educate the public to the true usage? So long as engineering magazines and text-books use the word improperly, how can we expect engineers to become entirely clear in its use? It seems obvious that the place to begin is not with the public, but with engineering literature—at the other end of the line.

Now let us investigate the words commonly used in other countries and other languages to designate the man who runs an engine and the man who is a civil engineer (using the latter in the broad sense). To begin with, other languages do not contain a word directly equivalent to the English word "engine." The word commonly used in analogous to the English word "machine" and the different types of engines are designated by proper modifiers. Thus, in French and German, respectively, a steam-engine is a "machine a vapeur" and a "dampf-maschine." In consequence, the man who runs a stationary engine is designated by a word analogous to the English word "mechanic" or "mechanician." Other languages contain a word similar to the word "locomotive" to designate that particular type of engine. The word used to designate the man who runs a locomotive might, in most cases, be translated into English as "locomotive conductor."

The following table shows, in columns 2, 3 and 4, the words commonly used in various languages to designate the men who in this country are known as civil engineers, locomotive engineers and stationary engineers, respectively:

	Civil Engineer.	Locomotive Engineer.	Stationary Engineer.
French	Ingénieur	Conducteur de machine	Mécanicien
Spanish	Ingeniero	Conductor de locomotora	Maquinista
Italian	Ingegnere	Conduttore di locomotiva	Macchinista
German	Ingenieur	Lokomotivführer	Maschinist
Swedish	Ingeniör	Lokomotivförare	Maskinist
Danish	Ingeniör	Lokomotivförer	Maskinist
English (England)	Engineer	Engine driver	Engineman
English (U.S. and Canada	Engineer	Engineer	Engineer

From this table it is evident that in countries other than the United States and Canada there can be no misunderstanding as to the meaning of the word "engineer." Only in the English-speaking portion of North America is its use in a state of confusion. We have succeeded partially, though not entirely, in acquiring the habit of using the correct words in connection with the driving and care of automobiles. Why not correct ourselves in other respects? Nothing could be more logical than the forms used in England, where the civil engineer is known by his true name, the man who runs a locomotive is known as an "engine driver" and the man who runs or takes care of a stationary engine is known as an "engineman."

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*From an article by Capt. N. M. Stineman, Engineer, Officers' Reserve Corps, in the October Bulletin of the Affiliated Engineering Societies of Minnesota.

Personals

J. T. Gear, formerly city engineer of Kelso, Wash., has been appointed city engineer of Puyallup, Wash.

Frank S. Peck and F. W. Schreiber have been appointed engineers of the South Dakota Highway Commission.

A. J. Russell and J. C. Parker have opened offices in the National Realty Bldg., Tacoma, Wash., and will engage in a consulting civil engineering and architectural practice.

Arthur F. Shuey has been appointed superintendent of the Tampa Water Works Co. of Tampa, Fla. Mr. Shuey formerly was assistant engineer of the Florida State Board of Health.

Prof. Almon H. Fuller, for the past 19 years a member of the faculty of the University of Washington, has accepted a position as dean of the department of civil engineering at Lafayette College.

The following officers, Engineer Officers' Reserve Corps, have been assigned to the 35th Engineers (Railway) at Camp Grant, Rockford, Ill: Capts. E. Burton Hocker, Reuben L. Rockwell, Joseph W. Moore, Frederick N. Hatch, John G. Hollman and Wilkie Woodard; First Lieuts. Louis T. M. Ralston and Fred C. McFarland; Second Lieut. Ephriam B. Wilkinson.

A special mission representing the Imperial Japanese Railways arrived in New York on Oct. 21. The object of the visit is to investigate the present transportation conditions in the United States, to inspect the principal industrial plants and mines, to study the loading and unloading of cotton and to observe the methods employed in the large railroad sorting yards. There is also the object of further developing the good feeling between the two countries that has been growing so rapidly since the United States entered the war. The Imperial Japanese Railways are represented on the mission by Jiro Nakamura, assistant traffic manager; Akio Kasama, secretary and purchasing agent; Dr. Yasujiro Shima, director of machinery and rolling stock, and S. Kobayashi, resident engineer at New York.

Industrial Notes

Henry M. Sperry has been appointed publicity representative for the Union Switch & Signal Co., General Railway Signal Co., Federal Signal Co. and Hall Switch & Signal Co., with headquarters at 120 Broadway, New York City.

T B Shertzer, formerly city manager of Portsmouth, Va., has been appointed to the new created position of eastern district engineer of the Hydrated Lime Bureau, Pittsburgh, with headquarters in New York City. C. W. Freitag, formerly construction superintendent for S. R. Smythe Co., Pittsburgh, has been appointed western district engineer of the Hydrated Lime Bureau, with headquarters at the home office in Pittsburgh.

The Westinghouse Electric & Manufacturing Co. has announced another increase in wages for shop employes aggregating another $2,000,000 a year. All employes observing shop hours, except munition workers, receive an additional bonus of 10 per cent if they are on a salary or time-rate basis, and of 7 per cent if they are on a piece, premium or task basis. The increases granted since the outbreak of the European war amount to about 60 per cent of the former average compensation.

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Volume XLVIII. CHICAGO, ILL., OCTOBER 31, 1917. Number 18.

A Great Opportunity for Appraisal Engineers

The war revenue law just enacted by Congress requires the determination of "the actual cash value of tangible property" of all corporations and partnerships. If carried out literally this means a gigantic amount of appraisal work in the next few months. At any rate it presents to valuation engineers an opportunity that the most wide awake will be quick to seize.

Ford, Bacon and Davis have issued a circular announcement that will interest many of our readers. It follows in full:

> In view of the present war tax emergency, Ford, Bacon & Davis desire to state that they are prepared to devote special attention to the appraisal of industrial and other property, especially for the purpose of war tax returns.
>
> The War Profits Tax section of the War Revenue Law just enacted by Congress requires the determination of Invested Capital in fixing not only the exemption of earnings but also the annual tax.
>
> Invested Capital under the definition of the act, includes "the actual cash value of tangible property paid in other than cash, for stock or shares in such corporation or partnership at the time of such payment (but in case such tangible property was paid in prior to January 1, 1914, the actual cash value of such property as of January 1, 1914, but in no case to exceed the par value of the original stock or shares specifically issued therefor.")
>
> Substantially all corporations and partnerships having property which was acquired prior to January 1, 1914, must ascertain the cash value of such property as of January 1, 1914, for the purpose of making tax returns under the Act.
>
> Also, corporations and partnerships having property which was acquired subsequent to January 1, 1914, must ascertain the cash value of such property as of the date when so acquired.
>
> In each case it will be necessary to satisfy the Commissioner of Internal Revenue as to the accuracy of the valuations thus made.
>
> An accurate and properly arranged appraisal is also invaluable for:
>
> 1. Calculation of Costs of Products,
> 2. Support of Balance Sheets and Income Statements,
> 3. Insurance and Tax Schedules and Adjustments.
> 4. Determination and Apportionment of Annual Depreciation,
> 5. Issuance and Sale of Securities.
>
> This firm, with its long practical experience and its trained staff of engineers, accountants and other technical experts, is peculiarly well qualified to make appraisals of industrial and other plants and properties for use in meeting the provisions of War Tax legislation and for the usual commercial purposes.

It will be noted that the revenue law specifies the "tangible property" only. Apparently the intent was to exclude "good will value," "going concern value" and the like. Yet the value of all "tangible property" in the form of manufacturing plants exists solely because of prospective income therefrom. In other words, capitalized prospective net earnings constitute the "cash value" of such plants; but to capitalize net earnings introduces the so-called "intangible values," such as "good will" and "going concern"—a pretty mixup!

This war revenue law is perhaps even more obscure in its phraseology than the various state public utility laws. For ten years engineers, commissions and courts have been struggling with the problem of ascertaining what basic reasoning should be applied in determining a fair "value for ratemaking purposes." Now they have a similar problem before them: What is "the actual cash value of tangible property" for taxation purposes?

To complicate the matter, the revenue law says that this "value" must "in no case exceed the par value of the original stock or shares specifically issued therefor." But suppose most of the plant was built with money derived from earnings that might have been distributed as dividends. What then? Is the company that did not issue stock against such a plant to be penalized, whereas a company that did issue stock, even to excess, is rewarded? We do not think so. It seems to us inevitable either that this law must be amended as to its letter or that the courts will read into it a spirit of reason and justice. In either case, it will become necessary to ascertain the actual investment in all plants as of Jan. 1, 1914, as well as the investment cost of building up the business of the plants—the development cost. This will involve no slight amount of engineering and accounting work.

We suggest to every appraisal engineer the advisability either of hiring skilled accountants or of forming a partnership agreement with an accounting firm. Then in soliciting valuation work, an engineer should emphasize the fact that co-ordination of engineering and accounting is essential to effective presentation of evidence to a court, and is highly desirable even where no court action is probable.

Co-Operative Purchasing Bureaus for Small Cities

A year ago J. F. Byxbee, Jr., city engineer of Palo Alto, Calif., addressed the League of California Municipalities, urging the co-operative buying of materials and supplies through a central purchasing bureau. He pointed out that small municipalities usually pay higher prices than private corporations, and that this results partly from the present practice of calling for competitive sealed bids.

At a recent convention of the League a resolution was adopted providing for an investigation of this matter by a committee. It is not unlikely, therefore, that California cities may soon unite in such a way as to enable them to apply the methods used by large corporations in buying materials and supplies.

A central purchasing bureau, if ably managed, would undoubtedly secure lower prices than would be obtained by the municipalities acting separately. Standard specifications alone cause price reductions where materials are purchased in large quantities. Then, if each municipality were required to provide a budget of its requirements, several months in advance, advantage could be taken of market conditions.

Mr. Byxbee has "started something" in California, which may eventually become common practice among groups of cities throughout America.

The Serious Decrease in Civil Engineering Students and the Remedy

For five years the number of engineering students has been decreasing. This was a serious enough matter before our entry into the world war. It has now become exceedingly grave.

In another article in this issue, we give statistics of enrollment of civil engineering students in 60 engineering colleges. In 40 of these colleges the enrollment in 1916 totaled 3,553 civil engineering students, as against 2,733 in 1917. Hence there has been a loss of nearly 24 per cent.

Fortunately the entering classes show a gain of 2 per cent, which is doubtless attributable to the advertising campaign described in our issue of Oct. 3. But there should have been a much larger gain, in freshman classes, and there would have been had the advertising been begun earlier in the year.

Since the opening of the college year the advertising of engineering colleges has again become conspicuous by its meagerness. At the very time that parents and young men should be reading advertisements intended to enlarge the engineering enrollment in the fall of 1918, the colleges are making practically no public appeal for patronage. Of course, this absence of business foresight is attributable mainly to the fact that colleges are not run for the profit of stockholders or owners. Nevertheless, colleges are presumably run for the profit of the public, and we can scarcely believe that an awakened public would not sanction the adoption of business methods if public profit were thereby increased.

Does it not now devolve upon the deans and professors of engineering colleges to prove what we engineers have been claiming for many years, namely that engineering is the one learned profession in which scholarship is wedded to business economics? If so, let those of us who now are, or ever have been, members of college faculties, bend our efforts to securing more publicity for engineering college courses. Let us seek to secure advertising appropriations with which to bring before the American public the worthwhileness of technical education. Let us have a voice in the writing of the advertisements, so that, without exaggeration or braggadocio, we may present the merits of technical training such as our engineering colleges give.

Advertisements of this sort should make it clear that engineering is the application of science to the problems of economic production. Once this conception of engineering becomes prevalent, there will follow a vast influx of students whose object is not to become "consulting engineers" but managers of manufacturing, mining and other industrial plants. Young men who now aim at large managerial positions are apt to take courses leading to an A. B., if they take any college course at all; for they have been told that an "arts course" broadens the intellect, whereas an engineering course narrows the mind. Let the advertisements of engineering colleges show that an adequate engineering course gives true breadth of outlook, opening fascinating vistas of the past achievements of science and still more fascinating prospects of future accomplishment. Let the advertisements name and describe the engineers who are industrial leaders—such men as Grace, the young engineer and president of the Bethlehem Steel Co.

By this sort of advertising it will be possible not only greatly to swell the numbers in our engineering colleges, but to create in the public mind a true conception of the importance and broadness of the engineering profession.

Price Changes for Structural Steel and Reinforcing Bars, During Past Year

The following tabulation prepared from reports from engineering departments of various cities shows the prevailing local prices on August 1, 1916, and on August 1, 1917, for structural steel and reinforcing bars:

PREVAILING LOCAL PRICES FOR STRUCTURAL STEEL AND REINFORCING BARS.

City.	Structural steel, f. o. b. city, per ton.		Reinforcing steel, f. o. b. city, per ton.	
	Aug. 1, 1916.	Aug. 1, 1917.	Aug. 1, 1916.	Aug. 1, 1917.
Ann Arbor, Mich.	....	....	$ 60.00	$ 90.00
Atlanta, Ga.	$105.00	$140.00	46.00	72.80
Bridgeport, Conn.	90.00	121.00	90.00	115.00
Columbus, O.	95.00	170.00	55.00	80.00
Boise, Idaho	....	....	*4.80	*6.55
Eugene, Ore.	....	....	53.00	113.00
Fitchburg, Mass.	....	....	....	[1]......
Great Falls, Mont.	*[2]4.38	*[2]6.28	*[2]4.38	*[2]7.58
Independence, Mo.	68.00	100.00	60.00	80.00
Kalamazoo, Mich.	*3.25	*5.15	*3.25	*4.65
Logan, Utah	70.00	120.00	90.00	125.00
Los Angeles, Cal.	....	....	*3.58	*6.10
Minneapolis, Minn.[3]	*3.20	*5.10	*3.20	*4.60
Mobile, Ala.	....	....	*4.00	*5.50
New Orleans, La.	58.20	96.20	74.00	100.00
Oak Park, Ill.	....	....	[4]80.00	[5]90.00
Ogden, Utah	....	....	*4.00	*6.00
Portland, Me.	80.00	120.00	52.00	100.00
Portland, Ore.	90.00	130.00	76.00	113.00
Provo, Utah	*4.02	*6.30	*3.52	*5.57
Quincy, Ill.	*5.00	*5.10	*4.75	*4.75
Red Wing, Minn.	....	....	....	*4.00
Rochester, N. Y.	*4.00	*5.34	*3.50	*4.80
St. Joseph, Mo.	68.40	96.40	68.80	117.00
St. Louis, Mo.	75.00	135.00	25.00	125.00
St. Paul, Minn.	*5.00	*8.00	....	....
Salt Lake City, Utah	110.00	150.00	80.00	120.00
San Antonio, Tex.	120.00	128.00	110.00	116.00
Seattle, Wash.	75.00	300.00	75.00	300.00
Spokane, Wash.	120.00	165.00	65.00	95.00
Syracuse, N. Y.	70.00	105.00	70.00	105.00
Tacoma, Wash.	70.00	100.00	70.00	*5.00
Vicksburg, Miss	....	....	*6.00	*9.00
Wichita, Kan.	....	....	80.00	120.00

*Per 100 lb.

[1] Advanced about 3 ct. per lb. [2] Less than carload lots. [3] Plates 3.6 ct. per lb. on Aug. 1, 1916; 7.1 ct. per lb. on Aug. 1, 1917. [4] $80 to $94. [5] $90 to $100. [6] Plates $5.20 per 100 lb. on Aug. 1, 1916; $11.50 per 100 lb. on Aug. 1, 1917.

Price of Copper Fixed at 23½ Ct.—President Wilson has approved the agreement between the War Industries Board and the producers, fixing the price of copper at 23½ ct. per pound. Copper has been selling at 26 ct. to 27½ ct. per pound in the open market. The price fixed by the president is subject to revision after 4 months.

Present Prices of Water Service Materials

Some interesting figures on the prices of water service materials were given by Mr. C. R. Knowles, Superintendent Water Service of the Illinois Central R. R., in a paper presented Oct. 16 at the annual convention of the American Railway Bridge and Building Association. The following notes are taken from Mr. Knowles' paper:

From the present outlook some relief appears in sight as regards prices of certain materials, the price of cast iron pipe having dropped $15 per ton on Oct. 1, although with the Government and foreign requirements in addition to the greatly increased domestic demands for materials of all kinds we cannot hope for much relief in the near future as far as deliveries are concerned.

While all materials have advanced in cost the increase has been more marked in iron and steel products, and articles manufactured from brass, copper and other semi-precious metals. Boilers have doubled in cost with indefinite dates of delivery on those built to specifications. Steel tanks of all kinds have advanced from 100 to 150 per cent, tank hoops from 75 to 100 per cent, steam pumps from 40 to 50 per cent, and oil engines 30 to 40 per cent with deliveries from 3 to 9 months, in the future, depending on the size of the units.

All stocks of steel and wrought iron pipe have been depleted and it is difficult even to get a quotation on a definite date of delivery on large pipe. The following table indicates the approximate prices prevailing on steel and genuine wrought iron pipe from 1914 to date:

	Steel pipe. Per ton.	G. W. I. pipe. Per ton.
January, 1914	$ 43.00	$ 55.00
July, 1914	42.00	54.50
January, 1915	43.00	55.00
July, 1915	44.00	55.50
January, 1916	47.00	59.00
July, 1916	68.00	85.00
January, 1917	82.40	103.00
July, 1917	114.40	143.00
Oct. 1, 1917	114.40	143.00

The above prices apply to base sizes, that is, ¾ in. to 3 in. B. W. steel and ¾ in. to 1½ in. B. W. genuine wrought iron. It is impossible to prepare a table on larger pipe that would indicate even an approximate price, as all quotations have been based on delivery and stocks on hand. To illustrate the scarcity of large wrought iron pipe, one of the largest oil well supply houses in the country has pulled well casing from the ground that has been in use for 19 years and paid the owner of the wells 20 per cent more for the pipe than was paid for it when new, 19 years ago. The pipe was then sold for double its original cost.

Delivery on cast iron pipe has been fairly good, although the price has more than trebled in two years. We are laying cast iron pipe today that ranges in cost from $18.50 to $60 per ton, while the lead used in making the joints has advanced from $3.75 to $11 in two years.

The following table shows the range in cost of cast iron pipe from 1912 to date:

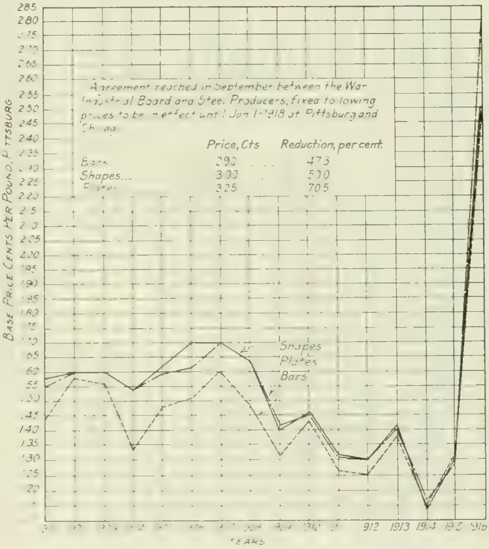
		Per net ton.
Year 1912	Approximately	$20.65
Year 1913	Approximately	20.35
Year 1914	Approximately	18.50
Year 1915	Approximately	18.60
Year 1916	Approximately	25.00
January, 1917	Approximately	32.75
July, 1917	Approximately	49.30
Oct. 1, 1917	Approximately	60.00

In justice to the cast iron pipe manufacturers it may be said that the increase in the cost of pipe has been more gradual than the advances in iron. This may be explained by the fact that the cast iron pipe manufacturers had some iron bought ahead and only advanced prices as the old contracts expired.

There are many reasons for the difficulty in securing material and delay to shipments, the chief reason being on account of the enormous amount of material going to foreign fields and taking precedence over orders for materials for domestic use. The shortage of labor and labor troubles have also had a serious effect on the material situation. The labor situation is daily growing more critical and will continue to affect the delivery of material. We cannot look for much if any improvement for the duration of the war.

Trend of Structural Steel Prices for Last 15 Years

The accompanying diagram shows the average prices of structural steel at Pittsburgh for the last 15 years. The figures for structural shapes are base for beams and channels 3 in. to 15 in., and angles 3 in. to 6 in. Prices for plates is f. o. b. Pittsburgh, and is for tank quality. Prices for bars is also Pittsburgh base and is for rounds and squares ¾-in. to 3/16 in.



Immigration This Year Lowest Since Start of War.—During the fiscal year ending June 30, 1917, a total of 362,877 aliens entered this country. The immigration in 1916 was 366,748 and in 1915 it was 432,244. In the fiscal year which ended June 30, 1914, the immigration was 1,403,081.

Increased Tonnage Carried by Railroads.—In July, 1916, railroads having 220,000 miles of track, or approximately 85 per cent of the entire trackage of the United States, gave service equivalent to carrying 27,809,430,998 tons of freight 1 mile, while this year they carried 33,434,368,526 tons 1 mile, an increase of exactly 20.2 per cent. The number of freight locomotives in service in July last year was 29,888, while this year the number was 30,277, an increase of only 1.3 per cent.

The Effect of the War on Enrollment in Civil Engineering Departments of American Colleges

A marked decrease in enrollment for the present year in the civil engineering departments of American colleges and universities is indicated by statistics collected by Engineering and Contracting. While the general college enrollment throughout the country is from 15 per cent to 20 per cent below normal, the percentage of decrease in number of engineering students apparently is somewhat greater than these figures. In order to obtain definite information on the latter point a questionnaire was sent to all colleges having courses in civil engineering. The results of this inquiry are summarized in Tables I and II.

It will be noted from Table I that the entering classes in 1917 in many institutions were not very much smaller than those in the previous year. In the upper classes, however, the decrease in enrollment is very evident. This is shown quite clearly in the following table which has been compiled from the returns from 40 different colleges:

	1916.	1917.	Increase or Decrease.
Entering Class	1,024	1,047	+ 23
Sophomore Class	834	694	—140
Junior Class	852	530	—322
Senior Class	843	462	—381

It will be seen from the above figures that while the number of new students in 1917 was 2 per cent greater than in 1916, there was a decrease of 19 per cent in sophomores, 38 per cent in juniors and 45 per cent in seniors. In other words, while these 40 civil engineering departments gained 23 students, they lost 820.

In some colleges there was a very encouraging increase in the enrollment of the entering class. At Pennsylvania State College the number of freshmen was much larger for 1917 than for some years preceding. In fact, at this institution the enrollment of freshmen engineers in all departments increased from 220 last year to 281 this year. At the University of Florida the total enrollment of new men in the engineering departments was the largest in the history of the institution.

On the other hand, Trinity College, Hartford, Conn.,

TABLE I—UNDERGRADUATE ENROLLMENT IN 1916 AND 1917 IN CIVIL ENGINEERING DEPARTMENTS OF 60 COLLEGES AND UNIVERSITIES.

(Several colleges, as indicated in the table, failed to furnish figures on class enrollment for both 1916 and 1917.)

	Entering —Class.—		Sophomore —Class.—		Junior —Class.—		Senior —Class.—		Graduates.	
	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.
Agricultural and Mechanical College of Texas	74	31	22	27	10	18	15	21	15	14
Alabama Polytechnic Institute	*	*	14	10	7	9	6	9	9	11
Armour Institute of Technology	22	19	16	9	8	14	8	17	17	17
Brown University	[1]64	[1]40	7	10	5	3	2	9	8	4
Case School of Applied Science	*	*	11	19	9	14	15	11	14	12
Clarkson College of Technology	26	44	29	20	8	18	16	30	10	10
Cornell University	85	114	59	96	46	69	38	112	101	74
Georgia School of Technology	..	34	..	32	..	10	..	12	10	7
Iowa State College	49	41	16	41	23	38	22	31	27	22
Kansas State Agricultural College	20	..	7	..	5	..	7	..	4	6
Lafayette College	20	21	16	19	16	18	11	21	21	23
Lehigh University	39	29	26	28	25	25	17	19	..	..
Marquette University	31	..	12	..	7	..	3	..	10	10
Maryland College of Agriculture	5	5	1	6	4	6	5	5	5	2
Massachusetts Institute of Technology	[1]515	[1]487	[1]467	[1]477	[1]348	[1]477	[1]315	[1]378	48	46
Mississippi A. and M. College	†	†	†	†	11	..	9	..	10	[2]2
Municipal University of Akron	6	..	4	..	6	..	2	..	..	..
New York University	27	42	13	28	17	32	13	31	?	?
Northwestern University	[8]20	[8]22	[8]5	[8]9	[8]1	[8]5	[8]3	[8]3	1	2
Norwich University	26	34	17	19	9	13	9	9	7	8
Ohio Northern University	32	..	14	..	11	..	16	..	39	34
Ohio State University	55	46	42	45	26	46	19	25	25	19
Pennsylvania State College	70	50	34	..	24	..	19	..	32	50
Polytechnic Institute (Brooklyn, N. Y.)	[3]23	[3]23	[3]19	12	[3]8	[3]16	[3]7	[3]17	[3]34	[3]27
Purdue University	66	75	46	42	20	40	23	45	52	54
Rhode Island State College	[1]47	[1]56	[1]31	[1]40	[1]22	[1]29	[1]11	[1]21	..	..
Rose Polytechnic Institute	12	16	7	3	2	12	10	5	8	7
State University of Iowa	*	*	14	11	9	15	14	14	13	12
Throop College of Technology	12	16	6	8	4	9	8	3	3	5
Tufts' College	†	†	†	†	15	17	13	18	15	9
Tulane University	19	9	7	7	5	7	3	6	6	3
Union College	59	84	54	67	12	17	9	26	24	9
University of Alabama	11	9	9	6	2	4	0	1	0	0
University of Arkansas	..	..	11	..	4	..	2	..	2	8
University of California	43	49	26	26	11	32	13	47	38	33
University of Cincinnati	53	34	20	28	16	51	13	11	11	19
University of Colorado	*	*	15	20	12	17	8	14	13	15
University of Florida	[4]*	*	5	5	3	0	0	2	1	3
University of Idaho	8	7	2	3	1	2	0	3	3	3
University of Illinois	47	57	32	53	45	43	24	43	37	39
University of Kansas	32	20	14	28	8	11	3	24	20	19
University of Kentucky	14	25	12	12	12	17	3	13	12	10
University of Maine	[5]175	[5]147	[5]100	[5]72	[5]45	[5]66	[5]55	[5]37	[5]51	[5]43
University of Michigan	[6]280	[6]383	51	67	50	105	67	82	75	74
University of Missouri	46	54	24	20	15	17	17	16	19	26
University of Nebraska	37	[10]26	[9]10	[10]27	[9]7	[10]26	[9]6	[10]24	5	6
University of Nevada	2	1	?	4	?	3	?	1	3	1
University of Oklahoma	..	..	5	..	4	..	5	..	2	5
University of Pennsylvania	49	44	28	35	21	36	21	31	29	32
University of Pittsburgh	15	..	3	..	6	..	8	..	6	11
University of South Carolina	25	25	15	12	12	15	8	5	4	6
University of Tennessee	15		11	..	4	..	5	..	1	3
University of Vermont	7	10	10	8	5	6	4	8	7	9
University of Wisconsin	52	51	26	26	11	23	12	28	32	36
Valparaiso University	40	40	14	..	11	..	10	..	15	17
Vanderbilt University	19	21	10	11	4	16	8	7	7	7
Villanova College	20	18	24	16	16	12	10	6	3	7
Washington University (St. Louis)	[7]20	9	5	10	5	12	9	7	7	9
West Virginia University	24	29	12	10	7	4	4	9	5	3
Worcester Polytechnic Institute	144*	186*	17	26	18	24	16	39	34	18

*All freshmen engineering students take same course. †Engineering course not differentiated in freshmen and sophomore years. [1]Students in all engineering courses. [2]Unusual; graduating classes for 6 years have ranged from 8 to 12. [3]In day work. The work is duplicated for men who attend in the day and for men who attend in the evening and on Saturday afternoon. The men who are taking their C. E. degree by working Saturday afternoons and evenings over a period of about 7 years number 131. [4]Total enrollment largest in history of the university. [5]Enrollment for entire College of Technology. [6]Unclassified. [7]Estimated; election of course not definite in many cases, as freshmen work is identical in all curicula. [8]Figures somewhat uncertain, as students in College of Engineering are not required to state whether they are candidates for C. E. degree or E. E. degree until the senior year. [9]First semester. [10]First and second semesters.

reports that its total enrollment is about 60 per cent of the normal but that the decrease in engineer students is considerably greater than the average for the entire college. At the Michigan College of Mines in spite of the tremendous demand for trained men in mining the registration this year is only 50 per cent of the normal.

An attempt also has been made to obtain information regarding the number of civil engineering alumni and undergraduates in the army and navy. Definite data on this subject could not be secured. Enough information, however, was obtained to indicate that a comparatively large percentage of the profession is in the service of the country. Reports from 24 colleges having a total of 5,746 living civil engineering graduates showed that 930 of these men already were in the army or navy. These, of course, are the minimum figures. Throop College of Technology, with 10 civil engineering graduates, has four of these in the army and 8 undergraduates in military service. The University of Michigan is estimated to have 300 of its 1,058 living civil engineering alumni in the army or navy. Maryland College of Agriculture has 24 out of 73 graduates in the army.

Other colleges having a considerable proportion of their alumni in military service are Villa Nova with 14 out of 52 graduates; University of Vermont, 26 out of 206; Ohio Northern University, 150 out of 595, and the University of Colorado, 30 out of 175.

On the basis of the figures noted above for the 24 civil engineering departments, 16 per cent of their alumni are in the army and navy. No other profession probably has so large a proportion of its members in the service of their country.

From 1890 to 1912 engineering schools grew very rapidly in their enrollment. About 1912, however, the number of engineering students began to decrease, and during the next four years only two technical schools made any material gains. As a consequence the great falling off in number of civil engineering undergraduates due to the war is a doubly serious matter.

TABLE II—ALUMNI AND UNDERGRADUATES OF CIVIL ENGINEERING DEPARTMENTS OF AMERICAN COLLEGES IN MILITARY AND NAVAL SERVICES.

(Figures are approximate only. As indicated in the table several colleges failed to furnished complete information.)

	No. living graduates, C. E. Department.	No. C. E. alumni in Army or Navy.	No. C. E. alumni in other government service account of war.	No. C. E. undergraduates in Army or Navy.	No. C. E. undergraduates in other government service account of war.	No. C. E. faculty in Army or Navy.	No. C. E. faculty in other government service account of the war.
Agricultural and Mechanical College of Texas	375	..	..	..	..	..	..
Alabama Polytechnic Institute	275	..[1]	..	..	..	1	..
Armour Institute of Technology	..	15	..	..	..	0	1
Brown University	150*	..	.	10*	3*	1	0
Case School of Applied Science	283	31	..	9	..	1	.
Clarkson College of Technology	112	8*	..	2*	..	1	..
Cornell University	1,801		..	..	..	5	0
Georgia School of Technology	74	18[2]	..	..	..	..	..
Iowa State College	604	..	..	..	..	..	..
Kansas State Agricultural College	76	9	2	7	0	0	0
Lafayette College	360	38	..	10	..	0	0
Lehigh University		..	..	..	..	..	..
Marquette University	.	6[11]	.	5*	..	1	
Maryland State College of Agriculture	73	24	3	5	2	0	0
Massachusetts Institute of Technology	1,332[5]	.	..	..	..	..	..
Mississippi A. and M. College	123	5[3]	..	1	0	0	0
Municipal University of Akron	...[4]	[4]		2	0	0	1
New York University	540	32[6]	9[6]	22	5	11	2
Northwestern University	...	1	1	8	6	0	1
Norwich University	..	90	..	20	1	0	0
Ohio Northern University	595	150*	50*	50*	20*	1	0
Ohio State University	420*	24*	..	12*	..	0	0
Pennsylvania State College	461	.	..	40	..	5	0
Polytechnic Institute (Brooklyn)	262	..[7]	..[7]	6*	..	0	0
Purdue University	986	..		.	..	5	..
Rose Polytechnic Institute	185	19	2	1	0	0	0
State University of Iowa	286	16*	..	23[8]	..	..	1
Throop College of Technology	10	4	..	8	..	..	1
Tufts' College	285	32*		..	..	.	0
Tulane University	80	..	..	..	..	0	..
Union College	370*	..	..	18	0	0	0
University of Alabama	...	..	.	.	..	0	0
University of Arkansas	...	15	3	30	..	1	..
University of California	...	79	8	17	4	2	1
University of Cincinnati	...	27[9]	5*	40	..	1	0
University of Colorado	175	30	1	40	0	3	3
University of Florida	27	6*	..	1	..	0	0
University of Idaho	56	6*	..	..	..	0	0
University of Illinois	816	..	.		..	1	.
University of Kansas	?	35?	?	40	..	1	..
University of Kentucky	208	35*	.	20*	..	1	.
University of Maine	1,250[10]	?	?	50[11]	..	23[12]	
University of Michigan	1,058	300[13]	150[13]	50*	.	44[14]	0
University of Missouri	404	..	..		.	0	0
University of Nebraska	186	39	..	12	..	1	0
University of Nevada	16	4	.	3	..	0	0
University of Oklahoma	15	2	0	6	0	0	0
University of Pennsylvania	..	..	..	.	..	5	
University of Pittsburgh	725	52?	79?	15	..	1[15]	
University of Southern California	50	5	..	10*	..	0	0
University of Tennessee	...	..	.	..	..	1	.
University of Vermont	206	26	2	3	..	..	.
University of Wisconsin	590	..	..		..	..	
Valparaiso University	140	12*	0	10*	0	0	0
Vanderbilt University	...	..	..	..	..	0	0
Villanova University	52	14	8	21	7	0	0
Washington University (St. Louis)	205	20[16]	..	17	..	1	..
West Virginia University	119	16*	..	8	..	0	0
Worcester Polytechnic Institute	393	26	.	8[17]		1	0

*Approximately. [1]Known in general way that about 300 alumni, students and undergraduates are in army; exact figures or classification not obtainable at present. [2]At least this number; complete statistics not yet available. [3]From class of 1917; records uncertain for earlier classes. [4]Civil Engineering Department started 3 years ago. [5]Graduates of Civil and Sanitary Engineering Department. [6]Recent C. E. alumni. [7]"Considerable number." [8]"Of those in school last year." [9]Approximately; graduates in last 8 years. [10]Graduates of entire School of Technology. [11]Undergraduates of entire university. [12]University faculty. [13]"The University of Michigan has made no attempt to separate its alumni in service as between departments. There are over 34,000 living alumni. Thousands are out of touch. Some 3,500 to 4,000 are known to be in service. Probably when the records are all compiled the number will be greatly increased. In the case of fraternities where full data is at hand it is found that about 25 per cent of the men who have been connected during the last 15 years are in service. I would estimate that between 250 and 300 of the civil engineering alumni are in military service and that 100 to 150 more are in other service." [14]Total engineering faculty in war, 37; of civil engineering faculty, 1; in reserve corps, 3. [15]25 per cent of faculty. [16]Exact figures not available; not less than 20. [17]Undergraduates of last year's sophomore and junior classes. [11]From class of 1917.

Iron Ore Production and Iron and Steel Making Capacity in the United States

When the war ends there will be an extraordinary demand from this country and from Europe for iron and steel products for manufacturing and construction purposes. Can the United States meet these demands? Information on this question is given in a recently issued bulletin of the U. S. Geological Survey, from which the matter following is taken.

Prior to the beginning of the war—indeed, during nearly the whole of the year 1914—the iron industry was in a state of stagnation. Prices were low, there was but little domestic or foreign demand for iron and steel, and that little demand was easily met by the operation of mines and furnaces at a greatly reduced rate of output compared with that of the two preceding years. In fact, many companies that could have saved money by closing their mines and furnaces generously kept them in operation to an extent sufficient to support part of the army of people dependent on the wages earned in normal times.

The first effect of the European war on the financial situation in the United States was such as still further to discourage the buying of iron and steel products and to depress prices. This condition, of course, could not well be other than temporary, for the interference of war with industries in the belligerent countries could not fail to reduce the output of their mines and furnaces and to enlarge the demand for American iron and steel. It also seemed probable that domestic markets on the Pacific Coast, formerly supplied in large part by manufacturers in England, Belgium and Germany, would become open to American manufacturers, as well as markets in Canada, South America, and Japan.

Such trade revivals and readjustments require time for their accomplishment, even under the impetus of war conditions, and it was not until the middle of 1915, or until the war had been in progress nearly a year, that the demand for iron ores and metals had become general throughout the United States. Not until June or July, 1915, did the price of pig iron begin to rise, and although the year closed with prices $1 to $1.25 a ton higher than at the beginning of the year, the average price at blast furnaces of all grades of pig iron for 1915 was 21 cents lower than the average for 1914.

As soon as the demand for iron ore became heavy, about the middle of 1915, it met with a ready response, particularly in the Lake Superior district, where there was an increase in shipments of nearly 45 per cent in 1915, compared with an aggregate increase of about 12 per cent in the other iron-mining districts of the United States. In 1916 the heavy movement of ore began as soon as navigation opened, with the result that more than 66,500,000 gross tons was shipped from the lake district, an increase of nearly 41 per cent. The total shipments for the United States in 1916 amounted to 77,870,553 tons, an increase for the whole country of about 40 per cent. The increase in districts other than Lake Superior was about 41 per cent. The quantities mined, which are given in Table I, differ slightly from the shipments just mentioned.

At the beginning of 1916 extraordinary activity prevailed in the iron and steel industries, and this activity was maintained with comparatively little variation throughout the year, as is indicated by the record of pig-iron production by months, which ranged between 3,000,000 tons and slightly over 3,500,000 tons. The total production in 1916 amounted to 39,434,797 gross tons, compared with 29,916,213 tons in 1915, an increase of 32 per cent, following a 28 per cent increase in 1915. In the first six months of 1917 the output of coke and anthracite pig iron was 19,069,892 gross tons, compared with 19,410,453 tons in the corresponding period of 1916, a decrease of about 1.7 per cent.

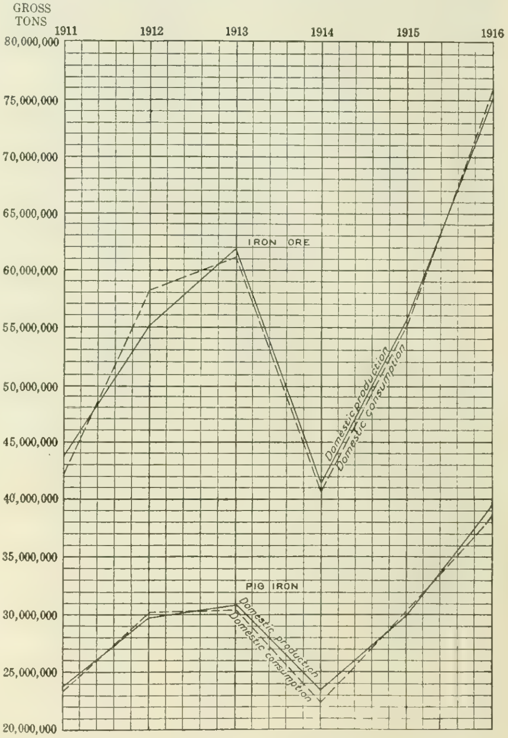


Fig. 1—Domestic Production and Consumption of Iron Ore and Pig Iron, 1911-1916.

The general average prices of iron ore per ton at the mines for the whole United States were $1.81 in 1914, $1.83 in 1915, and $2.34 in 1916. At lower Lake ports ore prices were advanced 70 to 75 cts. a ton for the season of 1916, after having remained sta-

TABLE I—IRON ORE MINED IN THE UNITED STATES, 1913-1916, IN GROSS TONS.

		1914		1915		1916	
	1913.	Quantity.	Increase or decrease (per cent).	Quantity.	Increase or decrease (per cent).	Quantity.	Increase (per cent).
Lake Superior (Minn., Mich., Wis.)	52,377,362	33,510,403	—36	46,944,254	+40	63,735,088	36
Birmingham, Ala.	4,602,573	4,282,556	- 7	4,748,929	+11	5,976,018	26
Chattanooga (Tenn., Ala., Ga., N. C.)	708,619	432,006	—39	539,024	+25	836,623	55
Adirondack, N. Y.	1,214,704	544,724	—55	699,213	+28	1,077,638	54
Northern New Jersey and southeastern New York	451,453	541,084	+20	644,493	+19	683,150	6
Other districts (south, central and western)	2,625,726	2,098,988	—20	1,950,577	— 7	2,859,155	47
	61,980,437	41,439,761	—33	55,526,490	+34	75,167,672	35

tionary since 1914. For the season of 1917 there was a general advance of $1.50 a ton, or 2.7 to 2.9 ct. a unit of iron. The 1916 and 1917 advances range between 15 and 21 per cent and 25 and 30 per cent, respectively. Compared with these modest advances prices of pig iron rose greatly during 1916. Southern foundry No. 2, at Birmingham, rose from $13 to $22 a ton, an increase of 69 per cent. Southern Ohio No. 2, at Ironton, seems to hold the record with an increase from $14 to $30, or 114 per cent, and the higher grades of iron also held up well, as indicated by the rise in Bessemer iron at Pittsburgh from $20 to $36, or 80 per cent. In the middle of July, 1917, the price of basic pig iron at western Pennsylvania Valley furnaces and of Bessemer pig iron at Pittsburgh reached $53 and $57.95 a ton, respectively, the highest points since the Civil War.

The bulk of the iron ore mined in the United States is produced in certain well-defined districts, and statistics of production by these units are of interest in showing how each has responded to the quickened demand for ore since 1914. The Lake Superior district mined nearly 85 per cent of the total ore in 1916, and the Birmingham district about 7.9 per cent, or less than one-tenth as much as the Lake district. The Adirondack is the only other individual district that mined as much as 1.000,000 tons. The increase in production in the Lake Superior district approximated 40 per cent in 1915 and 36 per cent in 1916; the other districts showed increases ranging between 6 and 55 per cent in 1916.

Comparatively little iron ore is imported into the United States—only 1,000,000 to 2,000,000 tons a year, or about 2 to 3 per cent of the quantity annually mined. Moreover, the exports of iron ore nearly offset the imports, so that the United States is at present self-sufficient so far as the supply of iron ore is concerned.

A comparison between the quantities of iron ore mined in the United States and those imported and exported in the last five years is given in the following table:

Year.	Mined.	Imports.	Exports.
1912	55,150,147	2,104,576	1,195,742
1913	61,980,437	2,594,770	1,042,151
1914	41,439,761	1,350,588	551,618
1915	55,526,490	1,341,281	707,641
1916	75,167,672	1,325,736	1,183,952

The imports of manufactured iron and steel (not including ferro-alloys) into the United States in the last three years have not varied greatly and are small in comparison with the exports, which have increased enormously, as shown in the following table:

	Imports.	Exports.
1914	$11,703,491	$ 65,988,280
1915	9,122,108	153,626,753
1916	11,098,607	362,524,715

A graphic comparison of domestic production and consumption of both iron ore and pig iron is shown in Fig. 1.

At the outbreak of the war the iron and steel industry was operating on a subnormal scale, and consequently the manufacturing capacity was in excess of requirements. Some of this excess capacity was, of course, represented by antiquated equipment that could not be put into shape for resumption of operations on short notice. The excess capacity at the oening of the war was greater in blast furnaces than in steel furnaces, so that one of the first effects of the war was to stimulate the building of new steel furnaces. The steel-making capacity at the beginning of 1915 was estimated at 37,500,000 tons, at the beginning of 1916 at 39,000,000 tons, and on Jan. 1, 1917, at 43,000,000 tons, and it is expected that by Jan. 1, 1918, it will amount to 48,000,000 tons. Thus there will have been an increase in three years of 10,500,000 tons, or 28 per cent, in steel-making capacity. The increase in capacity for basic-process steel is estimated to be about one-third greater than that for the acid process. The pig-iron capacity is estimated to have been more than 39,000,000 tons at the beginning of 1916 and to have been brought up to 40,000,000 tons at the beginning of 1917, but the prospective increase in blast-furnace capacity for 1917 is larger than for several years and will tend to close the gap between steel-making and pig-iron producing capacity, which has been becoming too wide.

The iron and steel making capacity at the end of 1917 will be none too large, judged by present and prospective demands, and probably it will not be large enough to fill orders promptly. The present excessively high prices are sufficient indication that the manufacturing capacity of the country is wholly absorbed. As to still further expansion there are of course limitations other than the demands for iron and steel. The capital involved in the iron and steel industry is so vast that ordinarily the future has to be taken seriously into consideration in planning new plants or additions to old plants. Wartime demands and prices, however, have upset many precedents and have encouraged many increases in plant capacity irrespective of the consideration whether or not they might prove excessive after the war. This has been particularly true of concerns whose profits have been great enough to pay off back indebtedness and pay for the additions to their plants within a year or two of their construction. In looking to the future the optimist has seen a demand heavier than normal after the war. Several factors in the domestic situation have appeared encouraging, such as the needs of the railways, of building construction, of the automobile industry, and of shipbuilding. Railway and general building and improvement work, except where urgently needed, is usually postponed in times of high prices and uncertain deliveries, but the longer these industries are deprived of supplies through such conditions the greater the flood of orders that will be released when conditions once more approach normal. Foreign trade with South America and the Orient is expected to grow, and European trade in the necessities of peace is expected to be augmented after the end of the war. The entry of the United States into the war and the demands of this Government for iron and steel of course once more raise the question whether further increases in capacity will be absolutely needed on that account. Certain large steel makers have patriotically assured the United States Government that they would furnish the steel needed for the war at prices very much below those current in the spring of 1917. This fact in itself may deter further increase in capacity, inasmuch as profits from such work sufficient to pay for the increase within a few months will not be in sight. It is probable also that the Government orders will be placed slowly and will not exert a sudden strain on manufacturing capacity.

There are also certain factors which will affect the manufacturing capacity just as vitally as insufficient equipment. Among these are limitation of supplies of coke and other fuel and of ore, due to insufficiency of transportation facilities and of labor, as well as shortage of labor at the steel mills. Some observers of the situation feel that the capacity for making crude metals will probably prove sufficient, but that the real problem lies in the ability to fabricate the special articles used in warfare, as well as in the industries expanded by war demands.

The Material Problem with Reference to Bridge and Structural Steel[*]

The breaking out of the European war created great activities in practically all lines of American commerce and industry, in which the natural economic laws of supply and demand governed. Unfortunately the railroads—while enjoying to some extent in these activities—could not enjoy the fruits thereof to the full extent and were, consequently retarded in their natural development for which we are now suffering. Owing to the prevailing uncertainties of the present situation, it is most difficult to correctly analyze the material situation of today. To convince one's self of the difficulty arising out of the situation, one has only to read the predictions made by eminent political economists and statesmen at the beginning of the great conflict.

As our steel conditions are intimately related to present European conditions, it might be well to give you some idea of the approximate maximum annual production of the various steel producing countries which are at present engaged in this war. The production of—

Great Britain in 1915 was	8,351,000	gross tons
France in 1913 was	4,635,000	metric tons
Russia in 1914 was	2,467,000	metric tons
Belgium in 1913 was	4,817,500	metric tons
Canada in 1915 was	911,000	gross tons
Italy in 1913 was	933,500	metric tons
	22,115,000	tons

The production of the Central Powers:

Germany in 1913 was	18,959,000	metric tons
Austria-Hungary in 1915 was	2,686,000	metric tons
	21,645,000	metric tons

Due to the fact that at least two-thirds of the French, and practically all of the Belgium steel producing facilities are in the hands of the Germans, the available European steel supply of the Allies is reduced to about 16,558,000 tons; whereas the Germans, undoubtedly, get some benefit from the Allies' properties which are under their control. Consequently, a large amount of steel must necessarily be furnished the Allies by this country in order to meet with their requisite supplies for the conduct of the war.

Prior, to the war, the maximum production of steel in the United States was 31,300,000 gross tons in the year 1913, which, due to the activities produced by the war was increased to 42,773,680 gross tons in 1916 (and is being still further increased during the present year), from which it will be noted that in the year 1916 the United States produced approximately 50 per cent of the entire steel production of the world.

Of the total production of steel in the United States, the structural material consisting of steel bars, shapes and plates constitutes about 12,400,000 tons. According to one of our New York leading financial publications, it is expected that the Government will require about 7,400,000 tons, leaving about 5,000,000 tons for other uses.

As all steel producing plants are booked ahead for a very long period and many orders are for material needed in connection with industrial and other purposes which are not essential from a national defense standpoint, the United States Government has established what is known as a "Priority Committee," with Mr. R. S. Lovett acting as chairman.

Through the issuance of the so-called priority classes and numbers, rolling mill schedules are arranged so that the material which is most urgently needed by the Government, as well as on Government work, is given preference. This applies not only to work for the Government, but also to other work which is just as urgently required, such as ship building plants, ships, and certain classes of railroad work considered necessary for the national welfare.

The regulations respecting priority which must be observed by all producers of iron and steel, as well as the manufacturers of products thereof, are briefly as follows:

All work shall be divided into three general classes designated as Class A, Class B, and Class C, with various subdivisions indicated by a suffix number, thus: Class A-1, Class A-2, Class B-1, Class B-2, etc. All work in Class A shall take precedence of work in both Class B and Class C and work in Class B shall take precedence of work in Class C, irrespective of the date the orders were received. Work in Class A-1 shall take precedence of work in Class A-2 and work in Class B-1 shall take precedence of Class B-2, etc.

Class A comprises war work; that is to say, work urgently necessary in carrying on the war, such as arms, ammunitions, ships, etc., as well as materials required in the manufacture of same.

Class B comprises work which, while not primarily necessary for carrying on the war, yet is of public necessity and essential to the national welfare.

Class C comprises all work not embraced in Class A or Class B and no certificate of the Priorities Commitee will be required therefore. However, an order for work or material not accompanied by a certificate to the effect that it falls within Class A or Class B will be treated as an order for work in Class C.

After a careful consideration of the steel problem, both as to production as well as the apparent government requirements, it would appear that there will be sufficient tonnage remaining for ordinary construction purposes with a reasonable time for deliveries.

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[*] From a paper presented at the recent convention of the American Railway Bridge and Building Association by Albert Reichmann of the American Bridge Co.

Steel and Iron Prices Fixed by War Industries Board

Under the agreement between the War Industries Board and the steel producers, the following prices, became effective immediately, and are subject to revision Jan. 1, 1918:

Average Prices of Shapes, Plates and Bars.

Commodity and basis.	Price agreed upon.	Per cent of reduction.
Iron ore, lower lake ports	*$5.05	.....
Coke, Connellsville	†6.00	62.5
Pig iron	*33.00	43.1
Steel bars, Pittsburgh, Chicago	‡2.90	47.3
Shapes, Pittsburgh, Chicago	‡3.00	50.00
Plates, Pittsburgh, Chicago	‡3.25	70.5

*Gross ton. †Net ton. ‡Hundredweight.

It was stipulated, first, that there should be no reduction in the present rate of wages; second, that the prices above named should be made to the public and to the Allies, as well as to the Government, and, third, that the steel men pledge themselves to exert every effort necessary to keep up the production to the maximum of the past, so long as the war lasts.

A comparison of the new prices with those of the last three years follows:

	Present prices.	1916.	1914.	Fixed prices.
Pig iron	$45.00	$24.00	$14.00	$33.00
Coke	13.00	4.78	2.32	6.00
Steel bars	4.25	2.48	1.15	2.90
Steel plates	8.00	2.82	1.14	3.25
Shapes	4.50	2.50	1.16	3.00

Bidding Prices on Public Work During Last Two Months

Contractors' Figures on Constuction Undertakings in Various Sections of the United States

Levee Work, Fourth Mississippi River District.

Proposals were opened October 4 at New Orleans, La., by District Engineer, Fourth Mississippi River District, for levee work, the following bids being recommended for acceptance:

Name of levee.	Cu. yd.	Price bid. Cts.	Awarded to
Lower Tensas—			
Elkridge, Lot 1	170,000	27⅞	Helgason Bros., Vicksburg, Miss.
Elkridge, Lot 2	170,000	27⅞	
Atchafalaya—			
Old River	550,000	11.25	Grasser Contracting Co., New Orleans, La.
Lafourche—			
Brilliant Point	465,000	12.23	D. B. Hearin & Son and O. O. Ogden, Baton Rouge, La.
Bon Secour	188,000		
Pike's Peak	56,000		
Barataria—			
Happy Point	50,000	15.4	Lester F. Alexander, New Orleans, La.
Deer Range	80,000	15.94	
Magnolia	60,000	19.54	
Pontchartrain—			
Golden Gate-Oakley	450,000	9.74	Grasser Contracting Co., New Orleans, La.
Nita	105,000	12	Dameron-White Co., Ltd., Baton Rouge, La.
Lake Borgne—			
Kenilworth	65,000	15.4	Lester F. Alexander, New Orleans, La.
Harlem-Savoie	80,000	15.4	
Martin-Bohemia	21,000	19.94	

Brick and Asphaltic Concrete Pavement, Elgin, Ill.

Contracts for street paving as follows were awarded the latter part of September by the city of Elgin, Ill.: Paving on River street to Illinois Hydraulic Stone & Construction Co., Elgin, for the total sum of $23,161, unit prices as follows: Sand filled brick pavement laid complete on a 5 in. concrete base, including excavation, at $2.45 per sq. yd.; 6 in. x 24 in. cement concrete curb at 50 ct. per. lin. ft.; catch basins at $35 each; 8 in. clay pipe catch basin connections at 75 ct. per lin. ft.; manholes at $35 each; 24 in. vitrified clay pipe storm sewer at $2.00 per lin. ft.

The paving of Douglas avenue with 4,500 sq. yd. asphaltic concrete pavement was awarded to McCarthy Improvement Co. of Davenport, Iowa, for the total sum of $9,695; unit bids as follows: Asphaltic concrete pavement laid complete on a 5 in. concrete foundation including excavation at $1.98 per sq. yd. Cement concrete combined curb and gutter at 60 ct. per lin. ft.

Sheet Asphalt Repaving, New York City.

Bids were received Oct. 11 by the Department of Parks of New York City for furnishing all labor and materials required for repaving with sheet asphalt on concrete foundation, the main roadway of Bronx and Pelham Parkway, between Southern Blvd. and Butler St., and the southerly roadway of Bronx & Pelham Parkway, between Butler St. and Boston Road, Borough of The Bronx. The bidding prices on the work were as follows, (1) standing for bid of the Asphalt Construction Co., 208 Broadway, New York City; (2) bid of Dovney Asphalt Co., Inc., 515 E. 17th St., New York City; (3) bid of The Union Paving Co., 120 Broadway, New York City; (4) bid of Uvalde Asphalt Paving Co., 1 Broadway, New York City.

	(1)	(2)	(3)	(4)
Excavation, 4,200 cu. yd.	$1.40	$1.30	$1.50	$1.00
Portland cement concrete, 3,400 cu. yd.	7.10	6.97	6.50	6.90
Sheet asphalt, 20,520 sq. yds.	1.53	1.57	1.39	1.46
Blue stone curb, 350 lin. ft.	1.55	1.45	1.30	1.50
Curb reset, 4,350 lin. ft.	.30	.65	.35	.69
Total	$65,438	$64,299	$58,900	$61,146

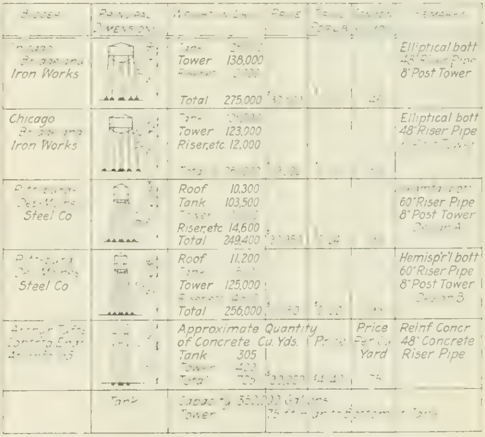
Jetty Repairs, Mantua Creek, N. J.

Bids were received September 22 by the U. S. Engineer, Wilmington, Del., for repairs to jetties at the mouth of Mantua Creek, N. J., which empties into the Delaware River about 10 miles below Philadelphia, Pa. The mouth is protected by parallel jetties about 400 ft. apart with a dredged channel 100 ft. wide between them. The depth of water along the face of the jetties where repairs are to be made varies from 0 to 8 ft. The mean range of tide at the mouth is 6 ft. and the locality is exposed to northerly storms. The work to be done consists in furnishing all materials and labor and making general repairs to the outer portion of the existing jetties in accordance with the aforementioned plan and these specifications. The existing jetties are of pile and timber construction with stone filling, and the repairs will consist of restoring the portions that have been damaged, replacing timbers that have decayed, and filling in with stone those places that have settled. The tops of the piles placed in the jetty and the tops of those cut off to be capped, together with both ends of the caps used in splicing, were to be treated with two coats of Avenarius Carbolineum, or equal. All surfaces of the timber were to be treated with one coat of Avenarius Carbolineum, or equal, before assembling. The unit bids were as follows, (1) standing for bid of Richard Parrott, (2) for Joseph Anderson, and (3) for Brown & Simpson:

	(1)	(2)	(3)
Yellow pine lumber, 21,000 ft. B. M., per M ft. in place	$127.50	$130.00	$138.38
White oak piles, fender and cluster, 680 lin. ft., per lin. ft. in place	1.25	.75	3.10
Caps for splicing, 120 lin. ft., per lin. ft. in place	2.00	1.50	4.90
Wrought iron, 10,000 lb., per lb. in place	.12	.12	.18
Stone, 410 cu. yd., per cu. yd. in place	3.50	3.75	4.80

Elevated Steel Water Tanks, Akron, Ohio.

Bids were opened September 24 by the city of Akron, Ohio, for constructing, furnishing and erecting an elevated steel water tank of a capacity of 350,000 gal., the tower to be 75 ft. high to bottom of tank. The bids received are shown in the accompanying sketch:



[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Iron Works		Tower 138,000 Total 275,000	[illegible]	Elliptical bott 8" Post Tower
Chicago [illegible] Iron Works		Tower 123,000 Riser,etc. 12,000	[illegible]	Elliptical bott 48" Riser Pipe
[illegible] Steel Co		Roof 10,300 Tank 103,500 Riser,etc 14,600 Total 249,400	[illegible]	60" Riser Pipe 8" Post Tower
[illegible] Steel Co		Roof 11,200 Tower 125,000 Total 256,000	[illegible]	Hemisp'r'l bott 60" Riser Pipe 8" Post Tower
[illegible]		Approximate Quantity of Concrete Cu. Yds. Tank 305	Price Per Cu. Yard	Reinf Concr 48" Concrete Riser Pipe
	Tank	Capacity 350,000 Gallons		

Bids received Sept. 24, by Akron, O., for Elevated Steel Water Tank.

Furnishing Rock for Fourth District, Mississippi River Commission.

The following bids were received Sept. 24 at New Orleans, La., by the District Engineer, Fourth Mississippi River District, for furnishing 23,000 tons of rock: Lester F. Alexander, New Orleans, La., $2.30 per ton on board U. S. barges New Orleans Harbor: Perry Grain & Cement Co. of Vicksburg, Miss., $1.10 f. o. b. cars quarry, 60 ct. for transferring rock from cars at Vicksburg to U. S. barges, the U. S. Government to pay freight with land grant allowance, shipments to be made on Government bills of lading.

Lower Otay Dam, San Diego, Cal.

Bids were opened Sept. 4 by the city of San Diego, Cal., H. N. Savage, Hydraulic Engineer, for the construction of the Lower Otay dam, and independent spillway, and an outlet tower and connections, and appurtenances, involving for the Lower Otay dam, about 30,000 cu. yd. of excavation, about 75,000 cu. yd. of concrete, about 20,000 cu. yd. of mass rock, and about 1,500 lin. ft. of hole for grouting foundations; and for the independent spillway, about 6,000 cu. yd. of excavation, about 2,000 cu. yd. of concrete; and for the outlet tower and connections about 750 cu. yd. of reinforced concrete. The work is located about 20 miles southwesterly from San Diego, and about 10 miles easterly from the Otay Industrial Track of the San Diego & Arizona Ry. and of the San Diego & Southwestern Ry.

Six bids were received, one of which was on the "cost plus" basis. This was submitted by the Shattuck-Edington Co., Los Angeles, which offered to do the job on basis of final cost of work plus 14 per cent on the bond issue of $682,200. The Wurster Construction Co., the low bidder on the unit price basis, requested the return of its proposal and certified check, giving as supporting reason that it had made a material error in transposing its figures from its detailed unit prices to its summation. The units bids received were as follows, (1) standing for bid of Wurster Construction Co., San Diego, (2) H. G. Fenton, San Diego, (3) James Kennedy, Los Angeles, (4) R. P. Shields, San Diego, and (5) Twohy Bros. Co., San Diego:

Reinforced Concrete Bridge, Tekamah, Neb.

Bids were opened August 14 by the city of Tekamah, Neb., for the construction of a bridge and retaining walls under plans prepared by Albert C. Arend, consulting engineer, Omaha, Neb. The plans called for a bridge of the reinforced concrete deck girder type, consisting of two spans of 34 ft. each, with 20 ft. roadway and 6 ft. each side for sidewalk and railing. Structure was to have capacity for 20 ton road roller. The bridge will span creek with clay bottom and usually no flow but occasionally 15 ft. depth of water. Plans covered about 170 lin. ft. of retaining walls, as wing walls. Total concrete, 530 cu. yd. Reinforcing steel, 40,000 lbs. Piles, 125 20 ft. long. About 1 cu. yd. concrete, 70 lb. steel and 0.35 piles were required per lineal foot of retaining wall. The bids received were as follows: Standard Bridge Co., Omaha, Neb., $14,220; James Saguin, Council Bluffs, Iowa, $13,500; Pickus Engineering & Construction Co., Sioux City, Ia., $13,885. The contract was awarded to the Pickus Co., with a deduction of $3,200 for 100 ft. of retaining wall not absolutely required at once. The unit prices submitted by the Standard Bridge Co. for computing the additions or reductions to be made to its bids were as follows:

Excavation, per cu. yd	$ 1.25
Sheet piling, per M ft. B. M. in place	70.00
Piling, per lin. ft. driven	.40
Concrete, footing class, per cu. yd. in place	12.50
Concrete, superstructure class, including all framework and bracing, per cu. yd.	21.00
Reinforcing steel in place, per 100 lb	6.00
Bridge railing, complete, per lin. ft	2.50
Typical retaining wall, complete, per lin. ft	15.50

Fill, Including Riprap Protection, San Pedro, Cal.

Bids were opened August 31 by the U. S. Engineer at Los Angeles, Cal., for constructing a fill, including riprap protection therefor, at San Pedro. The work involved 120,000 cu. yd. of fill. The Standard American Dredging Co., Los Angeles, offered to do the work at cost plus 17½ per cent. The San Francisco Bridge Co., San Francisco, submitted a bid of 97 cents per cu. yd. and Russell-Greene-Foell Co., Los Angeles, bid 82 cents per cu. yd. The latter company put in an alternate bid of 64.6 cents per cu. yd, with proviso that 15,000 cu. yd. for earth bulkhead be taken from roadway and bluff on Government Reservation.

BIDS RECEIVED SEPT. 4 BY CITY OF SAN DIEGO FOR LOWER OTAY DAM, SPILLWAY AND OUTLET TOWER.

	(1)	(2)	(3)	(4)	(5)
Schedule 1.					
Excavation, Class 1, 12,000 cu. yd	$0.62	$1.75	$1.13	$1.00	$1.90
Excavation, Class 2, 7,500 cu. yd	1.632	2.75	2.48	1.50	3.00
Excavation, Class 3, 1,500 cu. yd	.53	1.75	1.13	1.00	1.00
Excavation, Class 4, 9,000 cu. yd	1.283	2.25	2.48	1.50	1.50
Backfill, 500 cu. yd	2.026	.50	1.50	1.00	2.00
Concrete, 24,000 cu. yd	4.973	3.75	4.87	6.00	5.90
Concrete cyclopean masonry, 70,000 cu. yd	3.071	3.37	4.87	5.10	5.80
Concrete reinforced, 325 cu. yd	7.052	4.00	4.87	6.00	9.00
Placing reinforced steel, 30,000 lb	.0141	.0113	.02	.0009	.03
Crushing rock for sand, 10,000 cu. yd	1.08	1.00	2.00	2.00	1.50
Drilling holes, core recovering, 500 lin. ft	3.484	3.00	5.25	4.00	4.00
Drilling holes, percussion, 1,000 lin. ft	2.088	4.00	5.25	10.00	5.00
Grouting under pressure, 200 cu. yd	9.07	5.00	12.00	12.00	20.00
Laying drain tile and pipe, 2,000 lin. ft.	.275	.20	.15	.60	.35
Placing Metal work, 10,000 lb	.0345	.05	.0375	.0009	.03
Total for Schedule 1	$387,410	......	$547,837	$577,336	$639,725
Schedule 2.					
Excavation, Class 3, 1,000 cu. yd	.54	1.00	1.13	1.20	1.00
Excavation, Class 4, 5,250 cu. yd	1.50	2.25	2.48	1.50	1.50
Backfill, 500 cu. yd	1.18	1.00	1.50	1.00	2.00
Concrete, 600 cu. yd	4.97	4.00	4.82	6.50	6.50
Concrete cyclopean masonry, 200 cu. yd	3.50	3.50	4.82	6.00	6.50
Concrete reinforced, 1,200 cu. yd.	5.40	4.50	4.82	6.50	7.00
Placing reinforced steel, 30,000 lb	.02	.0117	.02	.0009	.03
Total for Schedule 2	$ 19,767	......	$ 25,110	$ 22,502	$ 24,375
Schedule 3.					
Excavation, Class 3, 100 cu. yd	.53	1.00	1.13	1.20	1.00
Excavation, Class 4, 200 cu. yd	1.40	2.25	2.48	1.50	1.50
Backfill, 300 cu. yd	1.00	.50	1.50	1.00	2.00
Concrete tunnel lining, 270 cu. yd	25.57	14.00	15.00	20.00	35.00
Concrete reinforced, 450 cu. yd	9.711	15.00	15.00	15.00	34.00
Placing reinforced steel, 20,000 lb	.0125	.01125	.02	.0009	.03
Placing metal work, 40,000 lb	.02	.05	.0375	.0009	.03
Total for Schedule 3	$ 12,956	....	$ 13,759	$ 12,924	$ 27,550
Total bid	420,134	450,000	586,736	612,762	691,650

H. G. Fenton's estimated cost exclusive of overhead expense and profit which is provided for in the contractor's proposal by a varying percentage based on final cost of work.

Sewage Disposal Works, Stamford, Conn.

Bids were opened September 22 by the city of Stamford, Conn., for the construction of sewage disposal works under the plans of Fuller & McClintock, consulting engineers, New York City. Three bids were received, one of which was on the cost plus basis. This was submitted by the Suburban Engineering Co., New York City, which offered to do the work at cost plus $12,500. The engineer's estimate was made in May, 1917, using prices of that time. The estimate and the unit bids were as follows, (1) standing for engineer's estimate, (2) for bid of Frank Palmer, and (3) for bid of Eaton, Brown & Simpson, Inc.:

Description.	(1)	(2)	(3)
Protective work and royalties, lump sum	$5,500	$26,500	$31,268
Excavation, 17,000 cu. yd.	1.50	1.25	1.32
Rolling embankment, 11,000 cu. yd.	.20	.65	.29
Concrete, 3,500 cu. yd.	16.00	21.25	17.25
Reinforcing steel, 200,000 lb.	.06	.06	.069
Cast iron B. & S. pipe, 43.5 tons	75.00	75.00	103.60
Cast iron B. & S. specials, 15.5 tons	115.00	80.00	189.00
Cast iron flange pipe and specials, 5.0 tons	150.00	90.00	262.00
Gate valves, lump sum	600.00	712.00	791.00
Sluice gates, lump sum	3,000.00	2,327.00	4,179.00
Check valves, lump sum	225.00	229.00	350.00
6-in. flap valves, 8 each	15.00	17.00	17.875
8-in. flap valves, 2 each	25.00	20.00	40.00
4-in. vit. pipe, 1,200 lin. ft.	0.15	0.25	0.20
6-in. vit. pipe, 20 lin. ft.	0.20	0.35	0.41
8-in. vit. pipe, 450 lin. ft.	0.35	0.75	0.50
10-in. vit. pipe, 700 lin. ft.	0.45	1.25	0.66
Structural steel, 65,000 lbs.	0.09	0.07	0.109
Misc. cast iron, wrought iron and steel, 20,000 lbs.	0.15	0.06	0.185
Railings, 480 lin. ft.	2.00	1.25	1.84
Screen chamber superstructure, lump sum	900.00	5,700.00	1,322.00
Laboratory building superstructure, lump sum	7,500.00	7,325.00	9,883.00
Lumber, 13 M. ft. B. M.	85.00	50.00	149.50
Baffles, including reinforcement, 2,560 sq. yd.	2.75	1.00	3.51
Venturi meter, lump sum	1,500.00	1,650.00	2,235.00
Chlorinating apparatus, lump sum	1,400.00	2,175.00	1,557.00
Automatic tide gate, lump sum	500.00	300.00	575.00
Chemical equipment & piping, lump sum	2,500.00	2,900.00	3,644.00
2-in. water line, 500 lin. ft.	0.70	1.00	0.575
Electric hoists, 2 each	350.00	532.00	583.00
Railways, steel ties, straight track, 560 lin. ft.	1.25	1.46	1.46
Railways, wooden ties, straight track, 600 lin. ft.	1.60	1.90	1.22
Railways, wooden ties, curved track, 100 lin. ft.	2.25	2.00	1.725
Switches, 9 each	60.00	70.00	75.00
Tip cars, 2 each	140.00	195.00	204.00
2-in. water line in settling tanks, lump sum	850.00	*1.00	1,119.00
Crushed stone, sludge beds, 770 cu. yd.	2.00	2.75	2.59
Macadam, 1,600 sq. yd.	1.25	1.00	1.78
Pressure water pump and motor, lump sum	500.00	650.00	632.00
Connecting existing pumps, lump sum	300.00	500.00	287.00
Fence, 865 lin. ft.	0.50	1.25	0.52
Total	$153,279	$192,857	$199,699

*Item 36 of Palmer bid was given as $1.00. Explained as meaning $1.00 per ft.

†Items 12 and 13 of Eaton, Brown & Simpson bid given as $143.00 and $80.00 respectively.

Mountain Division Hetch Hetchy Aqueduct Tunnel, San Francisco, Cal.

Bids were received Aug. 22 by the Board of Public Works of San Francisco, Cal., for the construction of 96,808 feet, or about 19 miles of aqueduct tunnel 10 ft. 3 in. in diameter on the Hetch Hetchy project, leading from Early Intake, 12 miles below the dam, to near the Priest's forebay reservoir above the power plant.

Bids were received from R. C. Storrie & Co., Healy-Tibbitts Construction Co., and the Lindgren Co., all large contractors in San Francisco. The lowest was by R. C. Storrie & Co., as follows:

	Feet.		City Engineer's estimate.
Section A	23,725	$1,983,725	$1,458,050
Section B	24,739	2,258,560	1,432,348
Section C	48,344	4,991,386	3,200,215
	96,808	$9,233,671	$6,090,613
Extra work and engineering			216,387
			$6,307,000

The low bid averaged $96 per lineal foot, including necessary structures. The bid was considered excessive and consequently was rejected. The unit bids on the work were as follows: (1) Standing of bid of R. C. Storrie & Co., (2) Healey-Tibbitts Construction Co., and (3) Lindgren Co.:

Item.	(1)	(2)	(3)
SECTION A.			
Tunnel No. 1—			
Standard lined tunnel, 23,725 lin. ft.	$83.00	$88.00	....
Addit'l excavation in tunnel, 400 cu. yd.	10.00	9.00	....
Addit'l concrete in tunnel, 400 cu. yd.	15.00	19.00	....
Excavation in open cut, 100 cu. yd.	8.00	3.00	....
Concrete in open cut, 50 cu. yd.	15.00	19.00	....
Reinforcing steel, 10,000 lb.	.10	.12	....
Weepers, 100	20.00	5.00	....
SECTION B.			
Tunnels Nos. 2, 3, 4, 5—			
Standard lined tunnel, 9,768 lin. ft.	90.00	....	....
Addit'l excavation in tunnel, 200 cu. yd.	10.00	....	....
Addit'l concrete in tunnel, 200 cu. yd.	15.00	....	....
Tunnels Nos. 6, 7, 8—			
Standard lined tunnel, 14,971 lin. ft.	90.00	....	....
Addit'l excavation in tunnel, 300 cu. yd.	10.00	....	....
Addit'l concrete in tunnel, 300 cu. yd.	15.00	....	....
Constructing adits, 200 lin. ft.	30.00	....	....
Concrete for sealing adits, 600 cu. yd.	15.00	....	....
Excavation in open cut, 100 cu. yd.	8.00	....	....
Concrete in open cut, 50 cu. yd.	15.00	....	....
Reinforcing steel, 10,000 lb.	.10	....	....
Weepers, 100	20.00	....	....
SECTION C.			
Tunnel No. 9—			
Standard lined tunnel, 12,300 lin. ft.	94.00	....	$115.32
Addit'l excavation in tunnel, 800 cu. yd.	10.00	....	10.00
Addit'l concrete in tunnel, 700 cu. yd.	15.00	....	30.00
Part of Tunnel 10 from Shaft 1 to point 3,000 ft. east of Shaft 2—			
Standard lined tunnel, 12,392 lin. ft.	94.00	....	115.32
Addit'l excavation in tunnel, 900 cu. yd.	10.00	....	10.00
Addit'l concrete in tunnel, 800 cu. yd.	15.00	....	30.00
West 3,000 ft. of Tunnel 10 and east 4,000 ft. of Tunnel 11—			
Standard lined tunnel, 7,000 lin. ft.	94.00	....	115.32
Addit'l excavation in tunnel, 350 cu. yd.	10.00	....	10.00
Addit'l concrete in tunnel, 150 cu. yd.	15.00	....	30.00
Part of Tunnel 11 from point 4,000 ft. west of Shaft 2 to point 2,500 ft. east of priest res. portal—			
Standard lined tunnel, 14,152 lin. ft.	94.00	....	115.32
Addit'l excavation in tunnel, 1,000 cu. yd.	10.00	....	10.00
Addit'l concrete in tunnel, 1,000 cu. yd.	15.00	....	30.00
West 2,500 ft. of Tunnel 11—			
Standard lined tunnel, 2,500 lin. ft.	94.00	....	115.32
Addit'l excavation in tunnel, 200 cu. yd.	10.00	....	10.00
Addit'l concrete in tunnel, 200 cu. yd.	15.00	....	30.00
Constructing Shaft No. 1, 613 ft. deep	250.00	....	146.00
Constructing Shaft No. 2, 784 ft. deep	250.00	....	141.00
Concrete for sealing shafts, 400 cu. yd.	15.00	....	25.00
Constructing adit, 50 lin. ft.	30.00	....	100.00
Concrete for sealing adit, 100 cu. yd.	15.00	....	25.00
Excavation in open cut, 100 cu. yd.	8.00	....	8.00
Concrete in open cut, 50 cu. yd.	15.00	....	25.00
Reinforcing steel, 20,000 lb.	.10	....	.08
Weepers, 500	20.00	....	4.00

Total, Sections A, B and C	$9,233,671
Reduction is Sections A, B and C are awarded in combination—none	....
Net total of Sections A, B and C	$9,233,671
Total, Sections A and B	$4,242,285
Reduction if Sections A and B are awarded in combination—5%	212,114
Net total, Sections A and B	$4,030,170
Total, Sections A and C	$6,975,111
Reduction if Sections A and C are awarded in combination—none	....
Net total, Sections A and C	$6,975,111
Total, Sections B and C	$7,249,946
Reduction if Sections B and C are awarded in combination—5%	362,497
Net total, Sections B and C	6,882.448

Brick Pavement, Parkersburg, W. Va.

The city of Parkersburg, W. Va., of which Wm. M. Hall is City Engineer, has awarded street paving contracts aggregating 17,000 sq. yd. to the following contractors under bids received Sept. 14: C. Kennedy & Son, for George St. with brick on reinforced concrete base; C. Kennedy & Son, for 20th St. with brick and sand and gravel base; C. Kennedy & Son, for 22d St. with brick on sand and gravel base; Graham Bros., Parkersburg, W. Va., for Spring St. with brick on sand and gravel base; Graham Bros., for Ann St. with brick on reinforced concrete base.

The unit prices for the above work are as follows:

Excavations	40 ct. to 60 ct.
Vitrified brick paving on 3-in. reinforced concrete base	$2.45 and $2.54 per sq. yd.
Vitrified brick paving on 6-in. sand and gravel base	$2.00 and $2.10 per sq. yd

Concrete Lined Reservoir, Cumberland, Md.

Bids were received Aug. 20 by the city of Cumberland, Md., Ralph L. Rizer, City Engineer, for the construction of a 7,000,000-gal. reservoir. The bidding prices were as follows, (1) standing for bid of Cumberland Contracting Co., Cumberland, Md., (2) for bid of The Rust Engineering Co., Pittsburgh, Pa., and (3) for bid of Cadmus Construction Co., New York City:

	(1)	(2)	(3)
Top soil excavation, 1,350 cu. yd.	$0.40	$0.63	$1.00
Earth excavation, 11,500 cu. yd.	.80	1.16	1.10
Rock excavation, 11,500 cu. yd.	1.60	2.42	2.30
Embankment, 22,000 cu. yd.	.30	.54	.60
Concrete in reservoir lining, 1-2½-4½, 1,180 cu. yd.	12.90	19.15	16.00
Concrete in gate tower and bridge, 1-2-4, 34 cu. yd. (lump sum)	850.00	24.75	25.00
Concrete, 1-2½-4½, not included in above, 10 cu. yd.	16.00	17.10	16.00
Reinforcing steel not included in lump sum bids, 4.5 tons	160.00	196.50	150.00
24-in. concrete inlet pipe, lump sum	1296.00	1920.00	2000.00
24-in. concrete outlet pipe, lump sum	1100.00	1530.00	1500.00
12-in. cast iron pipe, 22 lin. ft.	4.60	9.82	7.00
16-in. cast iron pipe, 465 lin. ft.	5.40	8.05	10.00
20-in. cast iron pipe, 240 lin. ft.	8.80	11.25	12.60
16-in. vitrified pipe drain, lump sum	390.00	700.00	242.00
16-in. sluice gates, 4 only	150.00	167.00	200.00
12-in. gate valves, with extension valve boxes, 3 only	80.00	210.00	80.00
16-in. gate valve, with extension valve boxes, 2 only	125.00	397.00	160.00
20-in. gate valves, with extension valve boxes, 1 only	150.00	760.00	250.00
Hand rail on bridge and gate tower, lump sum	150.00	344.00	400.00
Macadam roadways, 830 sq. yd.	2.50	2.90	2.00
Sodding, 800 sq. yd.	.36	.45	.60
Seeding, 1.5 acres	200.00	155.00	50.00
Fencing around reservoir, 1,630 lin. ft.	1.50	1.92	1.40
Concrete curbs and gutters, 600 lin. ft.	1.50	1.65	2.00
Storm water inlets, 2 only	260.00	130.00	50.00
Manhole head and cover on gate tower, 1 only	20.00	17.50	20.00
Total	$67,545	$99,796	$93,612

Sanitary Sewer System, Seymour, Ia.

Bids were opened Sept. 5 by the city of Seymour, Ia., for constructing a sanitary sewer system under plans prepared by M. G. Hall, consulting engineer, Centerville, Ia. The work was divided into six sections, the contract for these being awarded as follows: Sec. 1, lateral sewer, Moore-Seig Construction Co., Waterloo, Ia., $11,460; Sec. 2, lateral sewers, Comstock & Hanson, Cedar Rapids, Ia., $5,845; Sec. 3, outlet, W. H. Badell, Rock Island, Ill., $2,741; Sec. 4, outlet, Moore-Seig Construction Co., $1,568; Sec. 5, East disposal plant, Ward & Weighton, Sioux City, Ia., $9,700; Sec. 6, south disposal plant, Ward & Weighton, $7,100. The unit prices on the first four sections were as follows, standing for bid of (1) G. G. Herrick, Des Moines, Ia.; (2) J. L. Honsman, Des Moines, Ia.; (3) J. Q. Adams, Centerville, Ia.; (4) Comstock & Hanson, Cedar Rapids, Ia.; (5) W. H. Bedell, Rock Island, Ill.; (6) Petersen & Schriber, Omaha, Neb.; (7) Moore-Seig Constr. Co., Waterloo, Ia.; (8) Ivan Ipsan, Fairfield, Ia.; (9) Estimate.

Storm Sewer, Holdrege, Neb.

The city of Holdrege, Neb., opened bids September 27 for constructing a storm sewer, the contract being awarded at the following prices:

400 lin. ft. 12-in. sewer per ft.	$0.72
584 lin. ft. 18-in. sewer per ft.	1.24
814 lin. ft. 21-in. sewer per ft.	1.57
1,047 lin. ft. 30-in. sewer per ft.	2.76
20 lin. ft. 36-in. sewer per ft.	3.81
1,019 lin. ft. 12-in. sewer per ft.	0.72
74 lin. ft. 15-in. sewer per ft.	0.98
29 lin. ft. 18-in. sewer per ft.	1.24
9 manholes, each	35.00
For system complete	$6,412

This is only a small job but is otherwise desirable work. The time of completion is Dec. 15th, and the digging is dry and easy. The pipe specified is double strength No. 2 quality. The reason for the very low bid on the work is undoubtedly the fact that it is a small job to finish out the season with, for the contractors' larger jobs are now nearing completion. The average depth of the job is probably 7 feet. The filling is to be flushed into the ditches, but no guarantee retainer is withheld. Grant & Fulton, Lincoln, Neb., are the consulting engineers.

Sewer Construction, Logan, Utah.

Bids were opened August 28 by the city of Logan, Utah, A. H. Chambers, City Engineer, for the construction of sewers in Sewer District No. 5. The contract was awarded to O. J. Parrott, Salt Lake City, Utah, and he began work on September 29. The unit prices of the bidders were as follows, (1) standing for bid of O. J. Parrott, (2) Lynch Construction Co., (3) H. P. Bair, (4) Ryberg Bros., (5) Olaf Nelson, and (6) Wheelwright Construction Co. Such bids received August 28 at Logan, Utah, for sewer construction in Sewer District No. 5:

Work and Material—	(1)	(2)	(3)	(4)	(5)	(6)
Excavation and back fill, 6,000 cu. yd.	$ 2.05	$ 2.34	$ 2.50	$ 2.48	$ 2.80	$ 2.55
9 manholes, 5 ft. dia.	70.00	75.00	75.00	80.00	75.00	80.00
11 manholes, 4 ft. dia.	60.00	65.00	65.00	70.00	60.00	75.00
Lumber, 6M	65.00	65.00	60.00	70.00	50.00	75.00
Gravel fill, 150 cu. yd.	1.00	1.75	1.50	2.00	1.00	1.75
4-in. concrete drain tile, 3,000 lin. ft.	.17	.12	.13	.15	.12	.15
No. 2, 4-in. vit. sewer pipe, 6,700 lin. ft.	.17	.18	.14	.15	.12	.20
Vitrified Pipe—						
4-in. pipe, 50 lin. ft.	.20	.30	.15	.16	.20	.25
6-in. pipe, 50 lin. ft.	.30	.40	.25	.28	.30	.60
8-in. pipe, 2,300 lin. ft.	.46	.50	.55	.55	.45	.65
10-in. pipe, 4,100 lin. ft.	.52	.60	.60	.65	.58	.80
15-in. pipe, 700 lin. ft.	1.00	1.00	1.10	1.10	1.00	1.10
Total using vit. pipe.	$19,694	$21,993	$22.818	$23,267	$23,887	$24,935
Concrete Pipe—						
4-in. pipe, 50 lin. ft.	.22	.35	....	.16	.20	....
6-in. pipe, 50 lin. ft.	.33	.45	....	.28	.30	....
8-in. pipe, 2,300 lin. ft.	.50	.55	....	.60	.45	....
10-in. pipe, 4,100 lin. ft.	.60	.65	....	.70	.58	....
16-in. pipe, 700 lin. ft.	1.20	1.10	....	1.25	1.00	....
Total using conc. pipe.	$20,256	$22,388	....	$23,692	$23,887	....
Time of completion, days	90	....	300	150	330	300

BIDS RECEIVED SEPT 5 BY CITY OF SEYMOUR, IA., FOR CONSTRUCTING SANITARY SEWER SYSTEM.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Section 1—Lateral Sewers:									
8-in. vitrified pipe, 9,896 lin. ft.	$0.99	$1.00	$0.95	$0.84	$0.85	$0.80	$0.79	.....	$1.03
10-in. vitrified pipe, 730 lin. ft.	1.20	1.20	1.20	1.68	.98	1.00	1.03	.....	1.24½
12-in. vitrified pipe, 894 lin ft.	1.22	.95	1.10	1.15	.95	1.10	.87	.....	1.017
Manholes, 27	50.00	45.00	50.00	43.00	48.00	50.00	50.00	.....	48.65
Drop manholes, 2	50.00	72.00	60.00	50.00	60.00	60.00	66.00	.....	70.00
Flush tanks, 7	80.00	85.00	75.00	70.00	85.00	90.00	90.00	.....	63.38
Section 2—Lateral Sewers:									
6-in. vitrified pipe, 300 lin. ft.	.90	.80	.85	.60	.70	.75	.64	.....	.85
8-in. vitrified pipe, 5,360 lin. ft.	1.25	1.00	.98	.79	.75	.81	.80	.....	1.074
10-in. vitrified pipe, 360 lin. ft.	1.10	.90	1.00	.89	.99	.90	.78	.....	.98
Manholes, 12	50.00	50.00	50.00	43.00	48.00	50.00	52.00	.....	60.00
Drop manholes, 2	50.00	60.00	60.00	50.00	60.00	60.00	66.00	.....	68.00
Flush tanks, 5	80.00	80.00	75.00	70.00	80.00	90.00	90.00	.....	50.00
8-in. c. i. pipe (extra), 72 lin. ft.	4.00	2.70	2.50	2.00	2.75	3.00	5.00	.....	2.00
Section 3—Outlet:									
12-in. vitrified pipe, 2,717 lin. ft.	.95	.99	1.10	1.19	.85	1.00	1.08	$0.95	.91
Manholes, 7	50.00	40.00	45.00	43.00	48.00	50.00	48.00	45.00	41.32
Concrete, 8 cu. yd.	10.00	14.00	20.00	10.00	12.00	15.00	30.00	26.00	12.00
Section 4—Outlet:									
10-in. vitrified pipe, 1,215 lin. ft.	1.15	1.00	1.00	.94½	.90	.90	.70	.85	.71
12-in. vitrified pipe, 605 lin. ft.	1.00	.85	1.00	1.30	.70	.94	.76	.95	.97
Manholes, 4	60.00	46.00	45.00	43.00	40.00	50.00	48.00	48.00	53.00
Drop manhole, 1	60.00	53.00	60.00	50.00	50.00	60.00	66.00	60.00	41.00

Bridge Work McIntosh County, Oklahoma. Proposals were opened Sept. 17 at Eufaula, Okla., by the County Clerk of McIntosh County, for bridge work. The bids received were as follows: (1) Standing for bid of Oklahoma Bridge Co., Oklahoma City, Okla.; (2) for bid of Froebe-Gray Construction Co., Muskogee, Okla., and (3) for bid of Midland Bridge Co., Kansas City, Mo.

BIDS RECEIVED SEPT. 17 BY McINTOSH COUNTY, OKLAHOMA, FOR BRIDGE WORK.

Bridge number, size and type.	Haul, miles.	Quantity, grade and material.	(1)	(2)	(3)
Group 1—					
Baptizing Creek—Concrete	2	4-in.—Raise bridge	....	$ 50.00	$ 69.00
Repair abutments		Concrete—1:3:6—118 cu. yd.	....	12.15	13.15
		½ in. square—225 lb.—Steel	....	6.90	6.58
		920 ft.—Oak lumber	....	40.00	47.00
		Total	$1,374.00	$1,536.58	$1,679.00
Possum Creek—Concrete	1	1,928 lb.—Structural steel	....	8.75	8.70
Repair abutments	1	36 cu. yd. 1:3:6—Concrete	....	11.00	16.91
16 ft. steel span	5	4,000 ft. oak lumber	....	45.00	50.00
	4	100 lbs. 40d nails	....	20.00	7.00
	2	Hauling and erecting 20-ft. span	....	50.00	131.00
		Total	$ 791.00	$ 854.00	$1,123.00
0-6-1—25 ft.—Concrete girder		400 yd. dry excavation	....	1.00	0.75
		58 yd. wet excavation	....	3.00	4.00
	3	81 yds.—1:2:4—Concrete	....	18.00	21.00
	[illegible]	5,489 lb. ½ in. sq. steel	....	6.90	7.00
		26 20-ft. timber piles	....	0.65	0.57
		Total	$2,952.00	$2,748.74	$2,913.00
0-3-1—20 ft.—Arch	[illegible]	32.3 cu. yd. 1:2:4 concrete	....	16.00	20.70
		62.4 yd. 1:3:6 concrete	....	16.00	18.00
		2,950 lb. ½ in. sq. steel	....	6.90	6.88
		Total	$1,768.00	$1,717.26	$2,007.00
H-1-2—20 ft. Arch	1½	56.74 yd. 1:2:4 concrete	....	....	20.18
		100 cu. yd. 1:3:6 concrete	....	....	16.07
		5,668 lb. ½ in. sq. steel	....	....	6.86
		Total	$2,826.00	$2,762.00	$3,135.00
		Grand total	$9,711.00	$9,617.57	$10,857.00
Group 2—					
A'-2-3 5 ft.—Concrete arch	2	14.42 cu. yd. 1:2:4 concrete	....	17.50	18.84
		1,002 lb. ½ in. sq. steel	....	6.90	6.87
		Total	$ 374.00	$ 408.99	$ 435.00
A'-4-2—30 ft.—Concrete arch	3	56.74 yd. 1:2:4 concrete	....	17.50	19.35
		43.50 yd. 1:3:6 concrete	....	15.00	16.70
		5,000 lb. ½ in. sq. steel	....	6.90	6.90
		Total	$1,785.00	$1,990.45	$2,044.00
31-9-13-1—2 20-ft.—Concrete arches	½	59.35 yd. 1:2:4 concrete	....	....	....
		152.71 yd. 1:3:6 concrete	....	....	....
		8,918 lb. ½ in. sq. steel	....	....	....
		Total	$8,162.00	$8,837.50	....
34-9-13-1 40 ft.—Concrete girder	½	40 yd. 1:2:4 concrete	....	....	17.50
		178 yd. 1:3:5 concrete	....	....	14.00
		11,700 lb. steel	....	....	6.74
		Total	....	$3,710.00	$3,978.00
		Group total	$5,621.00	$6,236.94	$6,457.00
Group 3—					
1-7-2—10 ft.—Concrete arch	1	15.78 cu. yd. 1:2:4 concrete	....	15.50	20.65
		16.22 cu. yd. 1:3:6 concrete	....	14.00	18.05
		1,978 lb. ½ in. sq. steel	....	6.90	6.93
		Total	$ 590.00	$ 621.75	$ 756.00
1-6-4—5 ft.—Concrete arch	4½	11.14 cu. yd. 1:2:4 concrete	....	19.00	21.37
		315 lb. ½ in. sq. steel	....	6.90	6.97
		Total	$ 227.00	$ 233.36	$ 260.00
1-6-2—10 ft.—Concrete arch	1½	15.78 cu. yd. 1:2:4 concrete	....	16.25	21.37
		6.70 cu. yd. 1:3:6 concrete	....	15.00	18.72
		1,711 lb. ½ in. sq. steel	....	6.90	6.97
		Total	$ 496.00	$ 539.53	$ 581.00
1-4-3—5 ft. Concrete arch	7	13.51 cu. yd. 1:2:4 concrete	....	17.50	22.70
		366 lb. ½ in. sq. steel	....	6.90	7.00
		Total	$ 257.00	$ 261.68	$ 333.00
C'-4-1—15 ft.—Concrete arch	[illegible]	22.78 cu. yd. 1:2:4 concrete	....	18.00	21.98
		10.84 cu. yd. 1:3:6 concrete	....	18.50	19.40
		1,911 lb. ½ in. sq. steel	....	6.90	7.00
		Total	$ 700.00	$ 728.64	$ 846.00
C"-5-3—5 ft.—Concrete arch	[illegible]	13.51 cu. yd. 1:2:4 concrete	....	18.00	22.70
		366 lb. ½ in. sq. steel	....	6.90	7.00
		Total	$ 278.00	$ 268.43	$ 333.00
C'-6-1—15 ft.—Concrete arch	6	22.78 cu. yd. 1:2:4 concrete	....	17.50	22.70
		15.82 cu. yd. 1:3:6 concrete	....	16.00	20.07
		2,600 lb. ½ in. sq. steel	....	6.90	7.00
		Total	$ 756.00	$ 821.17	$1,017.00
X'-4-1—2 10-ft.—Concrete arches	3½	26.87 cu. yd. 1:2:4 concrete	....	14.50	20.65
		11.25 cu. yd. 1:3:6 concrete	....	13.50	18.05
		3,400 lb. ½ in. sq. steel	....	6.90	6.93
		Total	$ 827.00	$ 776.09	$ 994.00
W-4-1—30 ft.—Concrete arch	5	56.74 cu. yd. 1:2:4 concrete	....	....	20.74
		60 cu. yd. 1:3:6 concrete	....	....	17.26
		3,700 lb. ½ in. sq. steel	....	....	6.86
		Total	$2,222.00	$2,246.00	$2,532.00
E'-3-2—15 ft.—Concrete arch	1-12	23.56 cu. yd. 1:2:4 concrete	....	....	18.55
	1½	42.10 cu. yd. 1:3:6 concrete	....	....	16.20
		3,080 lb. ½ in. sq. steel	....	....	6.81
		Total	$1,162.00	$1,179.00	$1,328.00
T-7-2—15 ft.—Concrete arch	1-12	32.34 cu. yd. 1:2:4 concrete	....	....	21.83
		36.67 cu. yd. 1:3:6 concrete	....	....	17.18
		3,332 lb. ½ in. sq. steel	....	....	6.96
		Total	$1,553.00	$1,316.00	$1,548.00
		Group total	$9,068.00	$8,991.65	$10,528.00

Levee Work in Upper and Lower St. Francis and White River Levee Districts.

Bids were opened Aug. 24 by the U. S. engineers at Memphis, Tenn., for about 3,400,000 cu. yd. of earth work in the upper and lower St. Francis and the White river levee districts. The bids received were as follows, (1) standing for Geo. F. Ramsey, 157 Clarke pl., Memphis, Tenn.; (2) for Walter Lee, Charleston, Mo.; (3) for Roach, Stansell, Lowrence Bros. & Co., Memphis, Tenn., and (4) for H. B. Blanks, Vicksburg, Miss.:

	(1)	(2)	(3)	(4)
Upper St. Francis Levee District:				
Sta. 30 to 31, enlargement, 75,000 cu. yd.	$0.345	$0.33	$0.35	....
Sta. 33 to 34, enlargement, 50,000 cu. yd.	.29	.28*	.32	...
Sta. 36 to 37, enlargement and set back, 115,000 cu. yd.	.35	.33*	.35	...
Sta. 40 to 43, enlargement and set back, 211,000 cu. yd.	.33*	...	.38	....
Sta. 41 to 48, banquette, 300,000 cu. yd.	.257	.26	.25*	....
Sta. 83 to 87, enlargement, 250,000 cu. yd.	..	...	.30*	....
Sta. 93 to 96, enlargement, 100,000 cu. yd.		....	.25*	...
Lower St. Francis Levee District:				
Sta. 130 to 133, banquette, 175,000 cu. yd.	.31	....	.29½*	..
Sta. 133 to 135, banquette, 105,000 cu. yd.	.31	....	.29½*	..
Sta. 135 to 137, banquette, 175,000 cu. yd.	.31	.	29½*	...
Sta. 137 to 139, banquette, 200,000 cu. yd.	.31	....	29½*	..
Sta. 139 to 140, banquette, 165,000 cu. yd.	.31	...	.29½*	.
Sta. 168 to 169, enlargement, 125,000 cu. yd.	...	.	45*	....
Sta. 171 to 173, enlargement, 140,000 cu. yd.	..	....	.29	$0.28*
Sta. 173 to 175, enlargement, 170,000 cu. yd.	..	...	.24	.22*
Sta. 175 to 177, enlargement, 169,000 cu. yd.	....	...	.29	.22*
Sta. 177 to 179, enlargement, 165,000 cu. yd.	..	.	27	.22*
Sta. 179 to 180, enlargement, 100,000 cu. yd.	....	....	.28	.30*
White River Levee District:				
Sta. 52 to 53, new loop and banquette, 260,000 cu. yd.	....	....	47	...
Sta. 61 to 62, new loop and banquette, 133,000 cu. yd.	....	...	35*	...

*Recommended for acceptance.

State Highway Construction, California.

The accompanying tabulation is a summary of the unit bidding prices on the principal items involved in the construction of sections of state highway in California. The bids on Jobs 1 and 2 were opened on Sept. 4; bids on the other three jobs were opened Oct. 8.

Job No. 1 covers Section B of Route 3, Division II, and is located in Shasta County. The bidders, in the order given in the table, were Palmer & McBryde, San Francisco; Richard Rothwell, Los Angeles, and Tieslau Bros., San Francisco. On this job the State furnishes pipe railing, reinforcing steel, wire mesh reinforcement, corrugated metal pipe, Portland cement, and material for new fences.

Job No. 2 covers Section D of Route 12 in Division VII, and is located in San Diego County. The bidders were: Holland Construction Co., San Diego; W. M. Ledbetter, Los Angeles; C. L. Hyde Construction Co., San Diego, and Richard Rothwell, Los Angeles. The State furnishes pipe railing, reinforcing steel, corrugated metal pipe and Portland cement.

No. 3 covers Section A of Route 3, Division III, in Butte County. The only bidder on this contract was the Municipal Improvement Co., Richmond, Cal. On this job the State furnishes pipe railing for culverts, reinforcing steel, Portland cement, corrugated metal pipe, sand and coarse aggregate.

Job No. 4 covers Section C of Route 1 of Division IV and is located in Sonoma County. The Municipal Improvement Co., Richmond, Cal., was the only bidder on this contract. For this job the State furnishes material estimated to cost $81,312, and including pipe railing for culverts, reinforcing steel, wire mesh or deformed bars for reinforcement for pavement, corrugated metal pipe, Portland cement, sand and coarse aggregate for concrete.

Job No. 5 covers Section A of Route I, Division IV, in Marin County. The four bidders on this job were F. Rolandi, San Francisco; Palmer & McBryde, San Francisco; A. J. Fairbanks, Willitts, Cal., and Edmund J. Tracy, San Francisco. The State furnishes for this job material estimated to cost $103,855. This includes pipe railing for culverts, reinforcing steel, reinforcement for pavement, corrugated metal pipe, Portland cement, sand and coarse aggregate for concrete.

BIDDING PRICES ON STATE HIGHWAY CONSTRUCTION IN CALIFORNIA.

	Job 1.	Job 2.	Job 3.	Job 4.	Job 5.
EXCAVATION WITHOUT CLASSIFICATION (Per Cu. Yd.).					
Cubic yards	57,000	25,500	10,500	42,000	97,000
Engineer's estimate	$0.55	$0.60	$0.75	$0.70	$0.70
Bidder No. 1	0.80	0.89¾	0.99	0.99	0.85
Bidder No. 2	1.25	0.80	. .	....	0.95
Bidder No. 3	0.83	0.87½	....	....	1.00
Bidder No. 4	....	1.25	....	....	1.00
12-IN. CORRUGATED METAL PIPE (Per Lin. Ft.).					
Lineal feet	2,200	...	120	32	738
Engineer's estimate	$0.60	.....	$0.70	$0.60	$0.60
Bidder No 1	1.90	.....	0.60	0.60	0.60
Bidder No. 2	1.00	....	.....	.....	0.80
Bidder No. 3	0.60	.....	...	.....	0.60
Bidder No. 4	...	....	.. ..	....	0.75
18-IN. CORRUGATED METAL PIPE (Per Lin. Ft.).					
Lineal feet	1,000	784	60	370	338
Engineer's estimate	$0.75	$0.85	$0.90	$0.80	$0.80
Bidder No. 1	1.00	0.90	0.80	0.80	0.80
Bidder No. 2	1.25	1.00	.....	.....	1.00
Bidder No. 3	0.80	1.00	.....	.....	0.80
Bidder No. 4	...	1.25	.....	.....	1.50
CONCRETE, CLASS A, PAVEMENT MONUMENTS (Per Cu. Yd.)					
Cubic yards	460	146	7,600	12,200	15,700
Engineer's estimate	$14.00	$18.50	$4.00	$5.00	$5.00
Bidder No. 1	17.50	15.00	5.74	5.60	4.80
Bidder No. 2	24.00	17.00	.....	.....	4.90
Bidder No. 3	19.50	15.00	.....	.....	7.00
Bidder No. 4	.....	24.00	.....	.....	4.00
CONCRETE, CLASS A, CULVERTS AND MONUMENTS (Per Cu. Yd.)					
Cubic yards	.....	.....	150	850	795
Engineer's estimate	.....	.....	$10.00	$12.50	$12.50
Bidder No. 1	.....	.....	12.50	12.50	15.00
Bidder No. 2	.....	.....	.....	.....	15.00
Bidder No. 3	.....	.....	.....	.....	16.00
Bidder No. 4	.....	......	.....	.....	6.00
REINFORCEMENT FOR PAVEMENT (Per 100 Sq. Ft.).					
Cubic yards	...	.....	.....	482,000	195,000
Engineer's estimate	.....	.....	.....	$0.15	$0.15
Bidder No. 1	.....	.....	.....	1.75	1.50
Bidder No. 2	.....	.....	.....	.....	0.30
Bidder No. 3	.....	.....	.....	.....	2.00
Bidder No. 4	.....	.....	.....	.....	0.50
GUARD RAIL (Per Lin. Ft.)					
Lineal feet	.....	1,500	200	8,000	5,225
Engineer's estimate	.....	$0.60	$0.35	$0.40	$0.40
Bidder No. 1	.....	0.60	0.40	0.40	0.50
Bidder No. 2	.....	0.60	.....	.....	0.50
Bidder No. 3	.....	0.75	.....	.....	0.50
Bidder No. 4	.....	0.90	.....	.....	0.70
MONUMENTS (Each).					
Each	156	190	58	131	201
Engineer's estimate	$1.00	$0.60	$0.50	$0.50	$0.50
Bidder No. 1	1.00	1.20	$2.00	2.00	1.00
Bidder No. 2	2.00	1.25	.....	.....	1.50
Bidder No. 3	1.50	1.50	.....	.....	1.00
Bidder No. 4	....	2.00	.....	.....	7.00

Reinforced Concrete Bridges, Macon County, Georgia.

Bids were opened Oct. 10 at Oglethorpe, Ga., by the Commissioners of Macon County for the construction of reinforced concrete bridge under the plans of Arthur Pew, consulting engineer, Atlanta, Ga. The contracts were awarded as follows:

(1) 50 ft. arch over Beaver Creek (¼ mile from depot in Montezuma) to Luten Bridge Co., York, Pa., at $3,497.

(2) Two 60 ft. arches over Buck (about 1 mile from Oglethorpe) to Luten Bridge Co., at $8,798.

(3) 100 ft. bridge over Whitewater Creek (¼ mile from depot in Ideal) to H. B. Hoppendietzel Co., Macon, Ga., at $7,334.

(4) 100 ft. bridge over Hog Crawl Creek (about 3½ miles from Dooling) to H. B. Hoppendietzel, at $7,114.

The foundations for the bridges will be in clay ground. Average height from top of floor of bridge to bottom of footing is 17 ft. for No. 1, 22 ft. for No. 2, 19 ft. for No. 3, and 18 ft. for No. 4. All the bridges except Nos. 1 and 2 consist of 24-ft. spans of deck girder type with slab floor. The roadway is 18 ft. and the grade of the road generally about 18 ft. above the bed of the stream. Ideal and Dooling are stations on the A., B. & A. Ry.; Oglethorpe and Montezuma are on the A., B. & A., and also on the Central of Ga. Ry. There are excellent roads to all of these bridges.

Pacific Highway, Washington.

Bids were opened Oct. 1 by the State Highway Commissioner, Olympia, Wash., for the construction of a section of the Pacific highway in Skagit County, from Blanchard to Burling, Sta. 290+55 to Sta. 348+98. The unit bidding prices on this work were as follows, (1) standing for bid of J. R. Wood, Seattle (awarded contract), (2) for bid of Skagit Construction Co., Mt. Vernon, Wash., (3) for bid of Chas. G. Huber, Seattle, Wash.:

Items	(1)	(2)	(3)
Common excavation, incl. haul of 400 ft., 6,020 cu. yd.	$0.40	$0.70	$0.45
Loose rock excavation, incl. haul of 400 ft., cu. yd.	1.00	1.50	.80
Solid rock excavation, incl. haul of 400 ft., 3,350 cu. yd.	2.00	2.50	2.25
Overhaul on any of above materials per each 100 ft., cu. yd.	.02	.03	.03
Clearing, 0.63 acre	100.00	100.00	150.00
Grubbing, 0.13 acre	100.00	150.00	150.00
Riprap, hand placed, cu. yd.	5.00	4.00	4.50
Timber and plank in place, incl. spikes and bolts, 316 M. B. M.	43.50	34.00	43.00
Piling cedar above, lin. ft.	.20	.10	.20
Piling cedar below, 12,000 lin. ft.	.61	.45	.65
Plain concrete pipe in place, 12" diam., 60 lin. ft.	1.50	3.00	1.49
Undergrade crossing, 59-ft. span, lump sum	2,550.00	4,000.00	2,687.00
Surfacing, 1,880 cu. yd.	2.10	2.70	2.25
Totals	$36,838	$38,071	$38,751

Sanitary Sewer System; Oakland, Neb.

Bids were opened Oct. 2 by the city of Oakland, Neb., for the construction of a sanitary sewer system under plans of P. A. Edquist, Engineer, Omaha, Neb. The trenching will be machine work. Digging is good and no water will be encountered, no bracing required. The maximum cut is 22 ft., the minimum cut 3 ft., and the average cut 10¾ ft. The unit bids received were as follows, (1) standing for bid of Compstock & Hansen, Cedar Rapids, Ia.; (2) for Katz Construction Co., Omaha, Neb. (awarded contract); (3) H. J. Petersen, Omaha, Neb.; (4) A. Caniglia, Omaha, Neb.; (5) W. S. Scott, Lincoln, Neb.; (6) M. S. Jackson, Rapid City, Ia.; (7) A. D. Sears, Fremont, Neb. (8) James P. Connolly, Omaha, Neb.; (9) Cady & Savonell, Sioux City, Ia.; (10) Peter N. Kruse, Spencer, Ia.; (11) W. B. Carter, Sioux City, Ia.; (12) E. P. Donahue, Omaha, Neb.:

Gravel Bitulithic Pavement, Salt Lake City, Utah.

Bids were received Sept. 27 by the engineering department of Salt Lake City, Utah, for "Paving Extension No. 138"—Gilman Drive, 11th E. to 12th E. Sts. The unit prices were as follows, (1) standing for bid of Strange-Maguire Paving Co., (2) Ryberg Bros., and (3) P. J. Moran:

Abutters' portion	(1)	(2)	(3)
Excavation, 175 cu. yd.	$0.80	$0.95	$0.90
Excess emb., 125 cu. yd.	.90	.95	.90
Gravel fill, 80 cu. yd.	2.00	1.75	1.50
Cement curb, steel reinforced., lin. ft.—			
6"x16" cvd., 14.9 lin. ft.	.80	.85	.85
6"x16"—18" G. cvd., 147.5 lin. ft.	1.30	1.25	1.25
Cement curb, plain—			
6"x16", 52.9 lin. ft.	.60	.55	.55
6"x16" cvd., 27.2 lin. ft.	.70	.70	.70
6"x16"—18" gut., 1,402 lin. ft.	1.05	1.02	1.00
6"x16"—18" G. cvd., 666.9 lin. ft.	1.15	1.20	1.20
6"x25", 20 lin. ft.	.80	.75	.70
6"x24" cvd., 14 lin. ft.	.90	.90	.80
6"x24"—18" G., 10 lin. ft.	1.30	1.20	1.20
6"x24"—18" G. cvd., 10 lin. ft.	1.40	1.35	1.35
False C. & G. cvd., 14 lin. ft.	1.40	1.30	1.40
False C. & G., 20 lin. ft.	1.50	1.20	1.35
18" gutter, 4.3 lin. ft.	.60	.60	.50
18" gutter, cvd., 81.2 lin. ft.	.70	.70	.60
Pavement-wearing surface—			
2" gravel bitul., 2,755 sq. yd.	1.35	1.42	1.45
Extra bitul., 5 cu. yd.	20.00	18.00	17.00
4" bitum. macad. base, 2,288 sq. yd.	.63	.65	.68
6" concrete base, 467 sq. yd.	1.00	1.05	.95
6" concrete pavement, 62 sq. yd.	1.75	1.75	1.80
4" cement sidewalk, 100 sq. ft.	.17	.16	.15
Removing old pavement, c. and g., etc., 47 cu. yd.	3.00	3.50	2.75
Mortar rubble retaining wall, 11 cu. yd.	15.00	16.00	17.00
Concrete capping, Class A, 1.15 cu. yd.	15.00	17.50	17.00
Concrete around pipes, 2.1 cu. yd.	9.00	8.00	11.00
5715—15"x20" C. O. box, C. I., cov., 2	35.00	32.50	30.00
5715—18" C. O. box, C. I. cov., 1	38.00	37.50	35.00
4756—16" C. O. box, A. F. cov., 2	40.00	37.50	35.00
5851—Curb inlet box, 1	20.00	25.00	20.00
6" drain tile, 300 lin. ft.	.40	.60	.50
12" vit. pipe, 201.8 lin. ft.	.90	1.00	.95
Altern.: 12" cement pipe, 201.8 lin. ft.	1.00	1.00	.95
12" W. I. pipe, 47 lin. ft.	7.25	7.50	8.00
Reset C. O. box cover, 1	10.00	10.00	10.00
4"x6" G. T., 19 lin. ft.	.30	.25	.35
4"x10" G. T., 120 lin. ft.	.40	.38	.45
Clean out and fill trees with concrete, 2	12.50	15.00	15.00
Total abutters' portion	$10,201	$10,563	$10,553
City's portion—			
Excavation, 175 cu. yd.	.80	.95	.90
Excess emb., 125 cu. yd.	.90	.95	.90
Pavement—			
2" bitul. top, 256.5 sq. yd.	1.35	1.42	1.45
4" bitum. macad. base, 256.5 sq. yd.	.63	.65	.68
Total, city's portion	$760.00	$815.00	$816.00
Total contract	$10,961	$11,379	$11,370

BIDS RECEIVED OCT. 2 BY THE CITY OF OAKLAND, NEB., FOR CONSTRUCTING A SANITARY SEWER SYSTEM.

Items and Quantities.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Pipe Lines.												
6-in. pipe sewer, 196 lin. ft.	$0.60	$0.50	$0.65	$0.60	$0.66	$0.66	$0.64	$0.50	$0.65	$0.40	$0.67	$0.54
8-in. pipe sewer, 18,789 lin. ft.	.70	.70	.70	.62	.76	.90	.72	.58	.78	.65	.78	.59
10-in. pipe sewer, 2,901 lin. ft.	.85	.75	.75	.85	.93	1.00	.83	.74	.86	.80	.86	.75
12-in. pipe sewer, 6,890 lin. ft.	.95	.87	.85	1.00	1.14	1.20	.97	.92	1.00	1.20	1.00	1.04
15-in. pipe sewer, 1,116 lin. ft.	1.50	1.15	1.32	1.50	1.45	2.50	1.15	1.96	1.35	1.80	1.32	1.59
18-in. pipe sewer, 1,292 lin. ft.	2.25	1.15	1.40	1.75	1.82	3.00	1.35	2.55	1.68	2.15	1.70	1.58
Total for pipe lines	$26,862	$24,189	$24,593	$25,057	$28,931	$34,862	$25,772	$24,963	$27,844	$27,666	$27,841	$24,348
Miscellaneous—												
10-in. cast iron pipe sewer, 36 lin. ft.	$3.00	$2.75	$3.00	$4.00	$5.00	$3.00	$4.00	$3.65	$3.50	$3.50	$3.50	$5.00
12-in. cast iron pipe sewer, 72 lin. ft.	3.50	4.00	3.50	4.75	6.00	4.00	5.00	4.00	4.00	5.50	4.00	6.00
Cast iron, 44,250 lbs.	.04	.03	.04	.045	.06	.04	.07	.04	.035	.035	.035	.04
63 manholes, 702 vert. ft., each	38.00	4.00	4.00	3.75	3.50	4.00	4.00	4.00	3.75	40.00	3.60	4.00
6 drop manholes, 89 vert. ft., each.	43.00	4.00	4.25	4.25	3.50	4.00	4.00	4.00	4.00	50.00	4.00	5.00
17 flush tanks 175 vert. ft., each.	70.00	9.00	5.50	6.75	7.00	6.00	5.00	7.50	7.50	75.00	7.50	6.00
3 lamp holes, 25 vert. ft., each	10.00	1.00	1.00	1.00	1.50	1.00	4.00	.80	.50	.80	.50	.50
Reinforced con. culvert, 1	200.00	4.00	500.00	50.00	1,000.00	200.00	300.00	2.40	200.00	2.80	200.00	250.00
Concrete bulkhead, 1	40.00	50.00	35.00	25.00	50.00	50.00	150.00	50.00	50.00	80.00	40.00	25.00
Total miscellaneous	$6,242	$6,928	$6,838		$8,348		$8,190	$6,975	$6,526	$6,545	$6,410	$6,972
Sundries—												
Extra Y junction, 6-in. x 6-in., each	$1.00	$0.50	$0.35	$1.00	....	$0.60	$0.75	$0.90	$0.65	$0.60	$0.80	$0.35
Extra Y junction, 6-in. x 8-in., each	1.00	.75	.45	1.25	...	.90	1.00	1.00	.75	.80	1.00	.45
Extra Y junction, 6-in. x 10-in., each	1.25	1.00	.55	1.50		1.00	1.25	1.20	1.00	1.20	1.40	.60
Extra Y junction, 6-in. x 12-in., each	1.40	1.25	.70	1.75		1.00	1.75	1.50	1.20	2.00	1.60	.70
Extra Y junction, 6-in. x 15-in., each	2.09	1.75	1.15	2.50		1.00	2.50	2.50	1.50	3.00	1.80	1.00
Extra Y junction, 6-in. x 18-in., each	3.00	2.00	1.40	3.25		1.00	3.50	3.50	2.00	4.00	2.00	1.60
Cast iron pipe, per pound	.06	.05	.05	.06		.04	.10	.05	.035	.045	.05	.07
Wrought iron, per pound	.10	.05	.18	.06		.08	.10	.10	.08	.045	.08	.07
Lead pipe, per lin. ft.	.50	1.90	1.35	.75		.30	.50	1.00	.40	1.10	.70	1.20
Concrete, per cu. yd.	12.00	12.00	18.00	12.00		8.00	13.50	12.00	18.00	17.00	18.00	12.00
Gravel, per. cu. yd.	3.00	2.00	4.50	3.00		3.00	2.00	4.00	4.00	3.00	4.00	3.50
Sand, per cu. yd.	2.50	2.00	3.50	2.00		2.00	1.50	3.00	3.00	3.00	3.00	3.00
Broken stone, per cu. yd.	3.00	3.50	4.50	4.00		2.00	3.50	4.00	4.00	5.00	5.00	4.00
Oak piling, per lin. ft.	1.50	1.00	1.00	..		1.00	2.50	1.00	1.00	.09	1.25	1.00
Pine lumber, per 1,000 B. M.	40.00	55.00	55.00	50.00		40.00	60.00	40.00	50.00	40.00	60.00	50.00
Extra grading, per cu. yd.	.70	.75	1.00	.50		.60	.50	.40	.60	60.00	.60	.60
Extra trench digging, per cu. yd.	.75	1.00	1.25	.75		.60	.60	.80	.90	75.00	1.00	1.00
Brick masonry, per cu. yd.	15.00	15.00	18.00	5.00		9.00	12.00	18.00	18.00	20.00	18.00	14.00
Rubble stone, per cu. yd.	10.00	12.00	12.00	..		9.00	13.50	18.00	18.00	20.00	25.00	20.00
4-in. drain tile, per lin. ft.	.25	.50	.45	.75		.40	.40	.20	.20	.30	.20	.20
1-in. galv. iron pipe, per lin. ft.	.75	.50	.75	.55		.35	.50	.60	.60	.60	.50	.50
Grand totals	$33,104	$31,118	$31,432	$31,790	$37,279	$41,517	$33,962	$31,939	$34,371	$34,212	$34,252	$31,321

Reinforced Concrete Highway Bridge, Prairie du Chien, Wis.

Bids were opened August 20 by the Prairie du Chien & Wynlusing Bridge Co., of Prairie du Chien, Wis., for labor and material for construction of a reinforced concrete highway bridge, under plans of J. H. A. Brahtz, Consulting Engineer, St. Paul, Minn. The bridge will consist of four 110 ft. and two 101 ft. parabolic truss spans of reinforced concrete, and a 60 ft. clear bascule draw span. Bids also were received for about 40,000 cu. yds. of earth fill for approaches. The bids received were as follows:

N. P. Fransen, St. Paul. Lump sum, $62,400. Unit prices. East foot increase of width in roadway, $30.00; per cu. yd. of concrete, $25.00; steel in place, 10 ct.; piles, per lin. ft., 90 ct.; excavation, $1.00; curb, per lin. ft., 50 ct.

Geo. J. Grant, St. Paul. Lump sum, $84,000. No unit prices.

Illinois Steel Bridge Co. 15 per cent of actual cost.

Siems-Helmer & Schafner. 8 per cent of actual cost.

These bids include the actual concrete work with an estimated yardage of 1900 cu. yd. and 210 tons of steel and piling under all piers and a 2-leaf 60 ft. clear Scherzer rolling light span. The bids did not include any grading in connection with the bridge, this being let under separate contract. The grading included about 40,000 yd. for which a price of 32 ct. a yard was submitted by the La Crosse Dredging Co. Most of this yardage could be pumped out of the river but had to be transported over about ½ mile maximum haul. Crushed rock could be delivered at the site for approximately $1.75 per yard. Sand could be obtained at the site from the river bottom. All material and tools had to be transported about 1 mile from the Milwaukee and C., B. & Q. Ry. companies' siding. The river bottom consists of fine sand and deeper down quicksand, which, however, would not interfere with the construction of said bridge, only occurring about 40 ft. below the river bed.

Levee, Work Mississippi River Commission, Third District, Vicksburg, Miss.

Bids were received Sept. 4 at Vicksburg, Miss., by the Mississippi River Commission, Third District, for about 1,100,000 cu. yd. levee work. It was recommended that contracts for the work in the Rosedale levee, 500,000 cu. yd., be awarded to Geo. F. Ramsey, Memphis, Tenn., and the remainder of the work to W. T. & E. M. Lowrence & Co., Memphis. The bids received were as follows:

		Rosedale			Tallula		Tennessee		
		Sec 1	Sec 2		Sec 1	Sec 2.	Sec. 1	Sec. 2.	Sec. 3.
No. of bid.	Manner of bidding.	250,000 cu. yd.		Ellesley & Shipland. 80,00 cu. yd.	89,000 cu. yd.	89,000 cu. yd.	115,000 cu. yd.	128,000 cu. yd.	99,000 cu. yd.
		Cts.	Cts.	Cts.	Cts	Cts.	Cts.	Cts.	Cts
1.	Regular	32.9	32.9	38	38	38	35	35	35
	Percentage	26.4	26.4	....	....	....	....	....	....
2	Regular	....	....	....	....	....	36	32	36
3.	Regular	....	....	31.47	31.47	....	....	....	....
4.	Regular	....	....	29	....	....	....	....	29
5.	Regular	39.5	39.5	....	....	....	33	28	27.75
6.	Regular	....	....	....	....	....	....	24.75	24.5
	Percentage	....	....	....	....	....	....	17.75	17.5
7	Regular	47.5	47.5	33.75	37.34	37.34	29.45	29.45	29.45
8	Regular	44.70	44.70	28	28	45	28	26	25

Names and Addresses of Bidders: (1) Geo. F. Ramsey, Memphis, Tenn. Bids all or none on Rosedale; all or none on Ellesley, Shipland, and Tallula, and all or none on Tennessee. (2) S. R. Hughes Construction Co., Vicksburg, Miss. (3) Jno. G. Sessions, Memphis, Tenn. Bids both or none on Ellesley & Shipland. (4) W. T. Beauchamp, Vicksburg, Miss. (5) J. A. Burt, Gunnison, Miss. (6) Helgason Bros., Vicksburg, Miss. (7) R. T. Clark & Co., Natchez, Miss. Bids all or none on Rosedale; all or none on Tallula, and all or none on Tennessee. (8) W. T. & E. M. Lowrence & Co., Memphis, Tenn. Bid both or none on Rosedale; and all or none on remaining six pieces of work. (9) Hercules Co., Ltd., New Orleans, La. Bid received after opening. Bid only on Sec. 2, Rosedale, at 41 ct. Cost, $102,500. Regular basis. Bidder No. 1 proposed to place 100 teams on the work on the percentage basis. Bidder No. 6 proposed to place scraper team outfit on the work on the percentage basis.

Willows and Poles, U. S. Engineer Office, New Orleans.

Contract for furnishing District Engineer at New Orleans, La., of U. S. War Department, with willows and poles, fiscal year 1918, has been awarded to R. M. Murphy Co., Inc., Venice, La. Price for willows, $1.75 per cord. Price for poles, $4 per cord. Contract is dated Aug. 22, 1917.

Asphaltic Concrete and Concrete Pavement, Charleston, Mo.

The city of Charleston, Mo., early in October awarded an $80,000 street paving contract to A. R. Young & Co., Lawrence, Kan., at the following prices: $2.02 per sq. yd. for 2 in. asphaltic concrete on 4 in. concrete base, $1.50 per sq. yd. for one course 5 in. concrete; 72 cts. per lineal ft. for combined curb and gutter.

Seawalls, Fort Warren, Boston, Mass.

Bids as follow were received October 4 by the U. S. Engineer, Boston, Mass., for the construction of seawells at Fort Warren, Boston Harbor, Mass.: (1) Bid of H. P. Converse & Co., 88 Broad street, Boston, Mass.; (2) bid of Bay State Dredging & Constructing Co., 247 Atlantic avenue, Boston, Mass.:

	(1)	(2)
Seawall, Type 1, Sec. A-B, 54 lin. ft.	$87.00	$75.00
Seawall, Type 1, Sec. C-D, 383 lin. ft.	54.00	50.00
Seawall, Type 2, 140 lin. ft.	19.00	12.00
Seawall, Type 3, 218 lin. ft.	56.00	30.00
Extra excavation, per cu. yd.	1.60	2.00
Concrete, per cu. yd.	12.00	10.00

State Road, Washington.

Bids were received Oct. 1 by the State Highway Commissioners, Olympia, Wash., for the construction of State Road No. 21 in Kitsap and Meson Counties, from Charleston to Clifton, Sta. 0 to Sta. 524. The bidding prices were as follows, (1) standing for bid of David Govan, Port Angeles, Wash. (awarded contract); (2) bid of Geo. A. Bandaret, Bryn Mawr, Wash.; (3) Hans Pederson Construction Co., Seattle, Wash.; (4) W. O. Bulette, Bremerton, Wash.; (5) Sloane Bros., Seattle, Wash.:

Item.	(1)	(2)	(3)	(4)	(5)
Excavation, incl. haul of 400 ft., 123,640 cu. yd.	$ 0.30	$ 0.39	$ 0.35	$ 0.39	$ 0.38
Overhaul on above material per each 100 ft., 118,400 cu. yd.	.02	.03	.01½	.02	.03
Clearing, 43.1 acres	175.00	150.00	150.00	160.00	315.00
Grubbing, 29.1 acres	150.00	400.00	150.00	225.00	225.00
Riprap, hand placed, cu. yd	2.50	5.00	6.00	7.00	4.00
Slope wall, cu. yd.	7.00	9.00	6.00	6.00	9.00
Guard rail in place, incl. spikes and bolts, lin. ft.	.40	.45	.50	.45	.50
Timber and plank in place, incl. spikes and bolts, 52.16 M. B. M.	35.00	35.00	40.00	35.00	40.00
Piling (fir) above, lin. ft.	.10	.50	.20	.35	.40
Piling (fir) below, 1,360 lin. ft.	40	.20	40	.45	.40
Piling (cedar) above, lin. ft.	.10	.50	.20	.35	.40
Piling (cedar) below, lin. ft.	.45	.20	.40	.45	.40
Logs for cribbing, lin. ft.	.18	.40	.25	.30	.25
Logs for culverts, 5,060 lin. ft.	.18	.40	.25	.35	.20
Plain concrete pipe in place, 12" diam., 890 lin. ft.	1.00	1.00	1.10	1.00	1.30
Reinforced concrete pipe in place, 18" diam., 1,274 lin. ft	3.00	4.00	2.25	1.75	2.50
Reinforced concrete pipe in place, 24" diam., 238 lin. ft	5.00	6.00	3.50	3.00	3.50
Reinforced concrete pipe in place, 30" diam., 78 lin. ft	6.50	8.00	5.50	4.00	5.00
Surfacing, 13,560 cu. yd.	1.25	1.50	2.00	1.50	2.50
Porous tile drain, 6" diam., lin. ft	.30	.75	.50	60	40
Porous tile drain, 8" diam., lin. ft	40	90	.75	.80	.60
Totals	$78,006	$102,376	$92,002	$92,725	$113,766

Road and Street Monthly Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellaneous

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

Volume XLVIII. CHICAGO, ILL., NOVEMBER 7, 1917. Number 19.

ATTENTION!

Turn back three pages to advertising page 20. The publishers of Engineering and Contracting have there printed a message that should interest you.

How a Contractor Promoted the Resurfacing of Pavements

The Murray Construction Co., paving contractors of Knoxville, Tenn., recently did some pavement promotion work that merits attention. There were certain old and badly worn brick pavements in Knoxville, some of which had been laid in 1892 on a 6-in. natural cement concrete base. The Murray Construction Co. requested permission from the City Commission to be allowed to surface a section of old brick pavement with asphalt, as an object lesson, and without cost to the city. The Commission naturally granted the request, and a few months later, pleased at the result, called for bids to resurface several brick streets with asphalt.

While our object in citing this case is to indicate to other contractors the possibilities that such promotion work offers, it is of interest to note that the Murray Co. placed the asphaltic binder coat directly on the old brick, after sweeping the brick, and thus filled up the holes. Then a Trinidad asphalt wearing surface 1½ in. thick was laid, and it gave such satisfaction that practically all the brick streets of Knoxville have been thus resurfaced, totaling 75,000 sq. yd.

Incidentally, the Murray Construction Co. submitted the lowest bids on much of the work.

Nearly every city has a considerable mileage of old pavements badly in need of resurfacing. Local contractors could frequently influence taxpayers to demand resurfacing, were the proposed method illustrated by such an object lesson as the Murray Construction Co. gave. In these times perhaps it would be feasible to secure the work on a "cost plus a fee" contract.

Natural vs. Portland Cement For Pavement Bases

The function of a pavement base being primarily to distribute wheel-loads over the subgrade, it is apparent that the most economic means of securing this result should be adopted. Waterbound macadam has often been used as a base for pavements, and doubtless would be used more frequently were engineers to study its possibilities more carefully. Natural cement concrete was used almost exclusively for the base of the best types of pavement until the price of Portland cement became low enough to attract the attention of city engineers.

In short, macadam, natural cement concrete and Portland cement concrete make satisfactory pavement bases. Hence the choice of any one of the three should ordinarily depend on the first cost per square yard.

The commonly specified mixes are 1:2:5 for a natural cement concrete and 1:3:6 for a Portland cement concrete base 6 in. thick. Hence it requires about a quarter of a barrel more of natural than of Portland cement per cubic yard of base. Therefore if Portland cement costs more than 25 per cent in excess of the cost of natural cement delivered on the job, and if the above mixes are the standards, the engineer should give consideration to the use of natural cement.

Mixing Gravel and Clay in a Concrete Mixer for Use on Roads

River gravel requires the addition of a clay binder to make a satisfactory road surface. Usually the clay is spread over the gravel and puddled into its interstices by sprinkling, assisted by harrowing. But the thought suggests itself that by using a concrete mixer sufficiently better results would be secured to justify the added cost.

A mix consisting of 15 per cent clay, 25 per cent sand and 60 per cent gravel could be run through a concrete mixer and compacted with rollers so as to produce a very uniform and remarkably dense pavement.

In this connection it may be well to point out how such a mixture should be rolled. Gravel mixed with clay by harrowing and dragging can not be rolled satisfactorily with a 10-ton roller. The heavy roller sinks into the mass, and often becomes completely stalled. The solution of the problem consists either in rolling in about 4-in. layers, starting with a hand roller, and using progressively heavier rollers, or in compacting in 6-in. layers, using a horse-drawn rolling tamper with projecting lugs that penetrate the mass and tamp it like the action of the feet of sheep or goats. The final finishing, in either case, can be effected with a 10-ton gasoline or steam roller.

In mixing clay with gravel, the editor has found it advantageous to use a road grader, the blade of which turns the mass over and piles it in windrows. By pushing the mass back and forth across the road in this manner, supplemented by harrowing and sprinkling, an excellent mixture is secured. Perhaps no better mixture is needed than one obtained in this way, but the matter is of sufficient importance to warrant the experiment above suggested as to the use of concrete mixers.

Present Road Construction and Maintenance In France: Will American Engineers Effect Changes?

Mr. William J. Weir, formerly an engineer of the U. S. Office of Public Roads, has recently sent an interesting account of road work in France to Director Logan Waller Page. Mr. Weir collected his information while acting as an ambulance driver in the war zone.

He says that, while most of the roadwork consists in maintenance, new roads are frequently built in locations not so directly exposed to enemy artillery. Thus a new road may be built along the lee side of a hill. A new and crooked road is often built near an old straight road that is open to gun fire, and traffic is shifted back and forth between the two roads, to confuse the enemy airmen, but the new road is given most of the traffic.

All crossroads are permanently marked with signs giving distances and directions to neighboring points. This is an invaluable aid to officers who are not familiar with the locality.

About half the traffic on the main roads consists of motor trucks, fleets of which roll steadily by in hundreds, spaced about 50 ft. apart and traveling 12 miles an hour or more. The trucks move in fleets, with an open convoy space of about 150 ft. between two fleets, to permit fast moving motor cars to slip in and out. Between two lines of trucks, one going and the other coming, there is always a space wide enough for a motor car to travel in one direction. By dropping into the convoy spaces between the motor trucks, motor cars can pass one another. This would not be possible on the narrow (16 to 18 ft.) paved roads common in America, but in France many of the main highways are macadamized for a width of 33 ft. Even this width is frequently crowded to capacity.

How great a factor in the success of the French armies these wide roads have been can only be conjectured, but the combination of wide pavements and numerous interlacing roads has certainly been of the highest importance.

All the French roads are surfaced either with broken stone or gravel. Concrete, brick and asphalt road surfaces are not used, and Mr. Weir is of the opinion that they would not be so well adapted for war purposes, because of the greater difficulty of repairing them hurriedly and with perhaps inadequate facilities. He points out that broken stone and a clay binder can be thrown into the ruts and holes, and that the motor truck wheels soon roll the stone into a solid macadam. Since most of the stone is broken by hand and is usually available near the road—from quarries or the ruins of buildings—there is seldom lack of the material needed to repair roads.

It seems to us that Mr. Weir has not given sufficient consideration to the fact that the more durable types of pavement would not readily cut into ruts even under the densest traffic. Hence fewer men and far less material would be needed to maintain an asphalt, brick or concrete surface than is required for macadam maintenance. Where a shell destroys portions of a road, hasty repairs could be made with macadam.

Although prisoners of war are largely used in roadwork, and therefore it may be argued that labor is cheap and machinery not so essential as in normal times, it seems evident that a much more extensive use of machinery is warranted right now. Men for industrial and farming purposes are sorely needed in France, and the use of American road machinery would effect the transfer of thousands of prisoners from the roads to the mills and farms. We expect, therefore, to see our American machines and methods effect some marked changes in the present French ideas on road maintenance and construction.

The "Cost Plus a Fee" Contract and a Suggested Sliding Scale Fee

Civil engineers and contractors alike have long rebelled at the practice of awarding public works contracts to the lowest bidders regardless of their experience, integrity and ability. Even where laws give the awarding official some latitude, as when the word "responsible" precedes "bidder," it usually involves criticism of the official if the lowest bid is rejected.

A new crop of inexperienced road contractors' hopes is sown every spring, only to be harvested in disaster every autumn. Experienced road contractors find it difficult to secure road work at living prices, and eventually the majority of them drift into other lines of work.

The war has served to focus attention upon this condition and it has led many highway engineers to consider the advisability of making radical changes. The "cost plus a fee" contract has consequently received an unusual amount of consideration. In Massachusetts, for example, recent contracts have been let under a "unit cost plus a fixed fee" form of contract. Thus, for earthwork the contractor receives the actual cost plus 6 ct. per cubic yard.

The only weakness of a "fixed fee" payment, or of a "percentage fee" payment, arises from the fact that the contractor may not exert himself sufficiently to keep down the cost. This weakness, however, can be eliminated by adopting a sliding scale fee, based on some standard daily, weekly or monthly performance.

For example, let the standard output of a concrete mixer be, say, 80 cu. yd. per day, and let the contractor's fee be 15 ct. per cubic yard when this standard output is maintained. This would yield him a daily fee of $12 on the mixer gang for mixing and placing concrete. Let the fee be increased 1 ct. per cubic yard for each 5 cu. yd. of increased daily output in excess of 80 cu. yd. and decreased in a similar ratio for any falling off in the daily yardage.

Such a sliding scale fee would stimulate a contractor, and it would result in securing low unit costs.

Since the fee would be determined by the engineer, it is evident that the award of a contract would depend entirely upon the engineer's judgment as to the relative fitness of the different contractors. Of course the door may thus be opened to collusion and fraud. But we are sanguine that the engineering profession is so free from dishonest members that this method of awarding contracts can be safely resorted to wherever civil engineers are given full authority to select the contractors. Important work perhaps should be awarded by a board of engineers in order to maintain public confidence.

American Engineers and Superintendents Wanted for Road Work in France

Civil engineers, contractors, superintendents and foremen who have had experience in highway work now have a chance to offer their services to their country. Road building battalions are being recruited and will form part of the 23d Regiment of Engineers. On advertising page 33 read the call for service in this battalion. Read it, and if your experience, age and health qualify you, consider seriously whether patriotism does not have precedence over any other duty or desire.

Col. Johnston writes us that experienced men of the highest class of ability are enlisting at a rapid rate. If you, yourself, are not able to enlist, you will perform a patriotic service by calling the attention of others to this opportunity. Clip out the advertisement on page 33 and mail it now to some road builder of your acquaintance.

Why Are There So Few Consulting Highway Engineers?

Road and street design undoubtedly requires as much engineering skill for its economic execution as is involved in the design of a water works plant. Yet although there are a goodly number of consulting engineers who specialize in hydraulics, there are very few highway consultants.

One reason for this difference is to be found in the prevalent opinion that the design of a highway is a relatively simple matter. Certainly there is simplicity in the drawings for a street or road, nor is there much about the specifications that the average man can not understand. The resulting design, in short, is so simple that the designer's skill and experience are quite apt to be overlooked. The mass of data that the skilled engineer is master of and uses in designing a highway is not in evidence; so it follows that the most able of highway engineers stands little chance of being called as a consultant even by the least well-informed city or county engineer. This has been the condition for generations and there is no evidence that a change is in progress.

A Construction Company That Will Send Its 1,000 Workmen to France

Mr. R. B. Oliver, president of the Oliver-Hill Construction Co. of Knoxville, Tenn., has submitted an offer to the federal government to send its entire construction plant and 1,000 negro workmen to France. Even should it prove impracticable to accept such an offer, the patriotic spirit that prompted it will be thoroughly appreciated. Doubtless there are many more contractors who would gladly come forward with similar offers if the government were to indicate that it would welcome such action. Half a year ago the Walsh Construction Co. of Davenport, Ia., made to the government an offer similar to that of the Oliver-Hill Construction Co. But the government did not at that time appreciate fully the war services that might be rendered by a large construction company.

The Clogging of Culverts and a Remedy

Culverts and small cross-drains often become clogged with earth, causing serious damage to a road. Where this occurs it will usually be found that the gradient or slope of the culvert is less than that of the ditch or stream bed just above the culvert.

The size of the grains of sand or earth carried by a stream is dependent on the velocity of the current. Some formulas indicate that the size of the grain varies as the 6th power of the velocity. Obviously if the velocity is even slightly reduced, there will occur a deposit of the earthy material. But although this is obvious to anyone who gives the matter the slightest thought, it is not unusual to find that an engineer has reduced the gradient of a stream bed through a culvert.

Incidentally it may be added that a similar error is often made in changing the gradient of a ditch, flattening the slope instead of holding to a uniform slope.

How Street Accident Causes Are Diagnosed in St. Louis

Mr. C. M. Talbert, city director of streets in St. Louis, has devised a simple method of reducing the number of street accidents. The police have reported accidents for years past, and the street railways have also kept accident records. These reports were studied, and the location of every accident was indicated on the city map by means of a colored tack. A group of such tacks indicated either unusual density of traffic, or some special cause of accidents, or both.

In studying the "accident corners" it was sometimes found that the pavement was very slippery, or that the street was poorly lighted, or that a jog in the street caused a bad congestion in traffic, or that the policing of the corner was insufficient, or what not. By comparing each "accident corner" with others of equal density of traffic, it became easy to determine the reasons for differences in the numbers of accidents, and thus to adopt preventive measures.

Experiment of Wisconsin Highway Commission in Improvement of Sand Roads by Hay and Tar Mats

By H. J. KUELLING,
Assistant to State Highway Engineer.

Under the new State trunk highway law of Wisconsin the Wisconsin Highway Commission found itself with the problem of looking after the maintenance of about 700 miles of almost pure sand roads. These roads were of such a nature that many of them were impassable in dry weather and often impassible in wet weather. In other words, these roads were in bad condition a considerable share of the summer season and a part of the spring season.

In times past many of the local communities had placed a covering of clay on those roads where any clay was available. Still other communities had placed some straw or hay on the traveled section, but this was always quite temporary, as the hay was soon ground to pieces or rotted away.

Sand Road Covered With Mat of Hay and Tar.

Applying Tar Treatment to Hay Mat.

Hay Laid in Trench on Sand Road.

Mr. Hirst, the State Highway Engineer, conceived the idea of making a mat of hay and tar, which would have some strength within itself and also would be able to withstand the elements.

With this end in view the State Highway Department in the month of August, 1917, constructed a few short sections built in various manners. After about 6 weeks' wear the condition of some of these sections was satisfactory enough to warrant the construction of a longer experiment. This latter piece was built during the first week of October and is somewhat over a mile in length.

No particular merits are claimed as yet for this type of construction; but it will be watched with a great deal of interest by the engineers of the department and the various local people who live in the sand sections of the State.

The experimental road was constructed about as follows: The road was first staked out as to alignment. A furrow was then plowed on each side of the road in order to hold the grader somewhat true to line. Needless to say, one team was able to accomplish this act. After the plowing was done two teams were hitched to a small road grader, and after several trips up and down the road a reasonably good trench was constructed.

The road had previously been divided into 12 sections, which were constructed as follows:

Section No. 1.—This section is 1,000 ft. long and 16 ft. in width. It is one of two sections that contains an appreciable grade, there being at one point about 200 ft. of 8 per cent. This particular hill has been a bugaboo for tourists for several years, and especially during the past season, because of the fact that this road is the main route from Portage to Kilbourn and thence on to Camp Douglas, where the Wisconsin troops have been in camp.

This section was covered with a layer of marsh hay, after which it was given about ⅝-gal. treatment of Tarvia "B," applied cold. A second layer of hay was then applied and slightly over a ½-gal. treatment given. The section on the steep hill was given a considerably larger treatment of tar than the flatter sections. After the last application of tar, sand from the roadside was spread by shovels over the entire section to a depth of about 1 in. The hay used on the section as well as on each one of the other sections was spread so that a ton covered about 350 sq. yd.

Section No. 2.—This section is 1,000 ft. long and 9 ft. in width. After the trench was constructed a layer of hay was placed and given about a ½-gal. treatment of Tarvia. This layer of hay contained about one-half the hay that was applied on the section. About one-half the remaining amount of hay was added and given a ¼-gal. treatment of tar. The remainder of the hay was then added in a third layer and this also given a ¼-gal. treatment of tar. The section was then covered with about 1 in. of sand from the roadside.

Section No. 3.—This section is 200 ft. long and 9 ft. wide. This section was short because of the fact that it was almost impossible to obtain rye straw as the farmers did not care to sell it.

The straw was placed on this section in the same manner as hay had been placed on the previous section, and in the same quantity as to volume but, of course, not as to weight, a ton of straw going much farther than a ton of hay. The straw was divided into two layers, each one receiving a ½-gal. treatment of tar. The whole section was then covered with about 1 in. of sand from the roadside.

Section No. 4.—This section was 1,000 ft. long and 9 ft. wide. The first layer of marsh hay was placed and, without having received any treatment of tar, was covered with about 1 in. of sand from the roadside. The remainder of the hay was then added and given a ½-gal. treatment of tar. This was followed with about 1 in. of sand from the roadside.

The subgrade conditions on this section varied quite considerably as the central part of the section had a harder subsoil than most of the road. The two ends, however, were exceedingly soft sand. This section appeared to be somewhat easier to construct than the other tarred sections owing to the heavy oiler not making as great a rut in the subgrade.

Section No. 5.—This section was 500 ft. long and 9 ft. wide. It consisted of two layers of hay, each of which was given a ¼-gal. treatment of tar. The second layer of hay on this section was extra heavy and caused considerable trouble by getting into the gears on the oiler. This section was also covered with about 1 in. of sand from the roadside.

Section No. 6.—This section was 500 ft. long and 9 ft. wide. The entire amount of hay was put on at once and given a ¾-gal. treatment of tar, after which the section was covered with about 1 in. of sand from the roadside.

The above six sections were the only ones in which the tar and hay were used together. Considerable trouble was had at first in getting the tar properly applied owing to the fact that the weather was fairly cool. To overcome this the tank car was heated, after which the sprayers on the oiler worked very satisfactorily, giving an almost uniform coating of ¼ gal. per square yard.

Section No. 7.—This section was 500 ft. long and 9 ft. wide. A layer of marsh hay was placed and covered with about 1 in. of local sand. The remainder of the hay was put on and also covered with about 1 in. of local sand, after which the road was thrown open to traffic.

Section No. 8.—This section was 150 ft. long and 9 ft. wide. A layer of rye straw was placed and covered with about 1 in. of sand. This straw was in poor condition because of the fact that it was from the 1916 crop. A second layer of the same kind and amount of straw was placed and also covered with about 1 in. of local sand.

Section No. 9.—This section is 100 ft. long and 9 ft. wide. The full computed amount of straw was placed in one layer and covered with about 1 in. of sand from the roadside.

Section No. 10.—This section was 550 ft. long and 9 ft. wide. The full computed amount of hay was placed in one layer and covered with about 1 in. of local sand.

Section No. 11.—This section was about 300 ft. long and 10 ft. wide. Owing to the fact that a great many local people believed that tar alone would be beneficial, this section consisted of about 1 gal. of tar placed directly upon the roadbed. No particular good is expected to result from this and it was constructed somewhat to show what not to do.

Section No. 12.—This section consisted of two pieces about 300 ft. long. On this section no trench was made and the hay was merely deposited on top of the sandy road, as the local people had been doing for several years. These sections were not given any treatment of sand from the roadside.

The cost of the entire experiment consisted of $7 worth of rye straw purchased at $6 per ton, and $156 worth of marsh hay purchased at $8 per ton delivered on the road. The cost of labor and teams was $216, and the cost of the tar $322, making a total of $701 for the construction of 4,977 sq. yd. which were treated with Tarvia to the extent of ½ gal. to somewhat over a gallon per square yard, and the 1,900 sq. yd. which did not receive any Tarvia treatment.

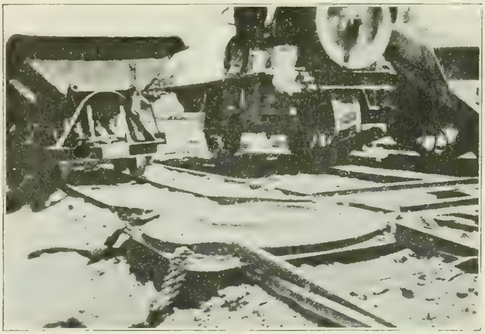
It is not hoped by the State Highway Commission that all of these sections will be an economic success. However, if a method is arrived at by which these sand roads can be made passable at reasonable cost the Commission will be satisfied. If the section that is now three months old, built in a similar manner, is any criterion, traffic will be well pleased with this type of road. On this section in question there is a very well compacted mat form which is carrying the traffic in a very satisfactory manner.

As stated by the writer, this experiment will be watched with a great deal of interest, and at some future date the Commission will be glad to publish a description of the condition of the road and what they believe concern it.

Concrete Mixer Charged Direct from Industrial Cars

Industrial cars dumping directly into an end charging concrete mixer are facilitating the construction of a section of the county highway system of Stanislaus County, California. The sand and gravel were hauled by motor trucks over the existing oiled road and deposited in stock piles about 1 mile apart. This material is transported to the mixer by the cars which operate on two parallel industrial tracks laid along one side of the road. Switches are located about 800 ft. apart. The trains, made up of 8 cars, are hauled by mules. Three trains are in use, one loaded train always being at the mixer.

The loaded cars are switched from the main track to a short section of rail directly in front of the mixer skip by means of a turntable, arranged as shown in the accompanying illustration.



Turntable for Switching Industrial Cars to Mixer.

The sand is loaded by hand into the bottom of the cars, and the gravel is loaded from a bunker fed by an engine-driven bucket conveyor. The cement is placed on the grade ahead of the mixer and is emptied into the skip. The mixer has a multiple opening discharge chute which allows the placing of four 3-sack batches without moving the mixer. This covers about 8 lin. ft. of pavement. During the construction of the first mile the largest day's run was 132 cu. yd. in 8 hours. This was accomplished with 15 men at the mixer, exclusive of the foreman at the mixer.

Koppel industrial cars and track are being used on this work. The McGillvray Construction Co. of Sacramento is the contractor and W. L. Fontaine is superintendent of construction.

The County Highway Engineer: His Duties and Responsibilities

During the past 5 years the duties of county engineers in an increasing number of States have become largely those of a county highway engineer. The 3,000 counties in this country are themselves expending annually for roads nearly 72 per cent of the grand total of $300,000,000 spent for the purpose throughout the United States. It is evident, therefore, that the county engineer has a position of increasing importance. An interesting discussion of the duties and responsibilities of the position was given by Dr. L. I. Hewes, Portland, Ore., District Engineer of the U. S. Office of Public Roads and Rural Engineering, in a paper presented at the recent convention of the Association of County Commissioners and County Engineers of the State of Washington. An abstract of the paper follows:

In the past to a great extent county highway engineers have necessarily been transplanted railroad engineers, former city engineers, or graduated civil engineers with little specialization. It takes but a year or two of actual road work, however, to convince the most skeptical that highway engineering has a distinct place among other branches of engineering, and that it deserves the place it is rapidly winning.

There are rapidly opening up in the 3,000 counties engineering positions that require high professional skill, but the path of preparation leading to these positions is not entirely clear, and the duties of these positions remain to a large extent undefined.

Often when a community becomes conscious that a road is needed from point A to point B a situation arises which defeats the best efforts of the highway engineer. The public importunes the administrative authorities to consider the needed improvement. There follows discussion and newspaper comment until a decision to build the road is reached. A non-technical committee then decides how wide (and often how thick) the road shall be, and how much money it shall cost. Then the highway engineer is called upon to construct the highway.

If he has failed under such circumstances to produce a road of the quality, depth, width, and grade visualized by the enthusiastic community, we should not blame him too severely.

This type of procedure is very common. The county highway engineer is not allowed to plan the work in the beginning. This inferior position to which he is relegated in the procedure has probably in the past misled many a young man to the idea that his duty was correspondingly easy and could be assumed with little or no experience. But he has been rudely awakened to the realization that the community does not inquire into the conditions under which he works when failures result, but holds him responsible only for results.

If the position of county highway engineer is to attain any professional dignity among the engineering group it would seem that it must cease to be elective and must command adequate salaries.* It is believed that county officers would prefer to make appointments to the position of county highway engineer, and such a method would avoid much conflict. If a State law could insure that such appointees qualified by examination prepared say, by the State Highway Department, the result would be correspondingly better.

Working in harmony with the county authorities well prepared and with a high sense of professional standards and adequately paid, the county engineer may hope to achieve a first essential in planning of his work, and that is to secure enough confidence on the part of his superiors and of the community, to allow him to expect a term of office extending over a period of years. It is idle to discuss planning of highway work unless sufficient time is presupposed to work out a plan. The public is learning, by repeated failure, that road reform does require time. If the county highway engineer can be insured of a reasonable tenure of office his work will be done with greater economy in the end. The difficulty with highway work is not an inherent technical difficulty, but a political difficulty causing constant interference with the technique.

It will doubtless be granted that the first technical duty of the county highway engineer is to study his county and to make a careful record of what he finds. This record should include a map on which the highways may be classified in two ways, first, with respect to their service to the community as through roads, market roads, or neighborhood or community roads; second, with respect to their type of relative improvement. Supplementing such maps there should be carefully plotted the location of all available road material as fast as discovered, with sufficient attached data to show where such material was used, when, and with what results, and the approximate cost. In addition to such field information, it is necessary for the county highway engineer to know thoroughly the financial history of the county and particularly the past expenditures for highways, the possibility of their increase, the indebtedness of the county, the relative amount used for schools, and other purposes. With this knowledge as a basis, the county highway engineer should make it his duty to institute modern cost bookkeeping methods in all the work he does. Such cost-keeping methods are summed up by the ideas of distribution of costs and development of unit costs. The reason for cost keeping is twofold; to prevent waste and inefficiency, and to enable intelligent planning of new work. State laws to this end could be made very effective.

The program for county highway work will be conditioned by the results of the field investigation and the financial history, and the effectiveness of the highway engineer will be measured by the skill with which he can develop efficiency under these limitations in a plan of road improvement for the county.

It is manifest that he must improve by new work certain miles of road each year, that he must maintain such new work with especial faithfulness, and that he must also repair additional miles of road and maintain those repaired miles, and furthermore maintain in a passable good condition the residue of the road mileage of the county. The equipment necessary for such work must be found and the distribution of expenditures must be planned.

It is a mistake for county highway engineers to take the attitude that conditions in their counties are "special conditions," that they have peculiar drainage, or subsoil or road material, and that therefore certain practices are permissible in that county that are manifestly against standard procedure. While it is admitted that the construction and upkeep of roads offer an endless variety of operating methods nevertheless well-tried principles underlie all such practice and only such principles will insure good results. For example, it is known absolutely that trap rock can not be bound with clay with economic results; that a boggy spot on a side hill cannot be cured by placing material on top of it.

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*The States averaged for engineering and inspection in 1914 about 8 per cent on about $25,000,000 of exclusively State work; at this rate each county in Washington could have averaged $9,641 for similar items for each of the past 10 years.

It may be that the entire highway engineering profession would be benefited by resignations when professional methods of the engineer are questioned or set aside. That many highway engineers continue in office doing work against their best judgment is unfortunate. Perhaps it is evidence that the engineers can not back up their judgment either with sufficient experience or with forceful English.

It seems to be true that the domain of highway work presents so many varied problems that chance for individual judgment is very great. It is correspondingly desirable, therefore, that highway engineers be absolutely informed as to the underlying or invariable principles that must obtain everywhere. The public must be taken into the engineer's confidence, the sympathetic co-operation of the newspapers is desirable, and it must be frequently understood that the engineer is proceeding under financial limitations over which he has little control. He must postpone the construction of much-needed improvement while he brings to a passable standard many miles of road that must be traveled every winter. If he can plan for a series of years it will be possible to survey the roads and establish their profile and work gradually toward the new plan and the new profile without loss. Culverts can be installed to correct grade and length if the complete profile and plan are available. Maintenance operations can be undertaken with full knowledge of what is to follow within the next succeeding year. The purchase of road machinery may be planned economically. The installation of crushing plants may be made with a view to their use beyond a single season. The purchase of culvert pipe may be made in a quantity and the general business of roads in the county handled on a permanent basis.

Creosoted Wood Blocks Laid on Bituminous Cushion

A bituminous cushion has been used for about 100,000 sq. yd. of creosoted wood block pavement laid during the past two seasons by the Department of Public Works of Detroit, Mich. This work has been done in the resurfacing and repaving of various streets.

In the Detroit work the base consists of a 1:3:6 concrete having a rough coat spread by means of a templet. While the concrete is still green a 1-in. topping composed of 4 parts of sand to 1 part of cement is spread on. This is finished as smoothly as possible much the same as a sidewalk. After the topping has dried thoroughly the surface is covered with a coat of tar. The tar is heated in two kettles and poured over the concrete by means of pails. It is then smoothed off with a squeegee. The blocks are then laid on this surface and rolled, after which the pavement is thoroughly sprinkled with water. A ¼-in. top dressing composed of fine river sand completes the work.

Mr. C. W. Hubbell, City Engineer of Detroit, advises that so far no trouble has been experienced with buckling of blocks in the pavement laid in the manner described above.

Road Drag Used in Gravel Road Construction

By J. C. WORRELL.

The road drag shown in the sketch is like one used on some highway construction near Merrimac, Wis. Most of the fills were made of sand and it was necessary to put on an average of 12 in. of gravel surfacing to make a good road. This drag served two purposes in making this road. Just before putting on the surfacing a team of horses was hitched to the pointed end and the drag was pulled down the center of the new road, making a path in the sand something like the snowplow used in cities for cleaning sidewalks. The gravel was then hauled and dumped in this trench, which was made about 12 in. deep and 9 ft. wide.

The gravel was usually first leveled by a man with a shovel, but sometimes this was done by hitching to the other end of the drag and going over the gravel until it became level. It was found to work better after the gravel had been packed and rutted up by traffic. By pulling from the wide end and allowing the pointed end to come directly over the rut, the gravel was leveled both ways into the rut, because the triangular shape tended to work the gravel toward the pointed end, which followed over the rut. It is necessary to go up over one rut and back over the other in order to fill both ruts and make a smooth surface.

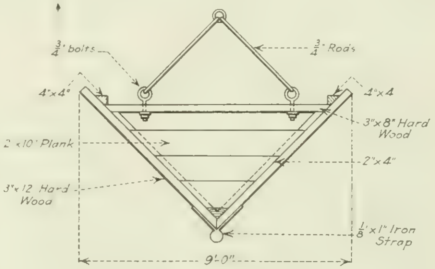


Fig. 1—Details of Road Drag.

The 3-in. x 8-in. piece (see Fig. 1) should be raised about 2 in. from the bottom of the 3-in. x 12-in. pieces so as to give the desired effect of letting the gravel work along the 3-in. x 12-in. pieces toward the pointed end of the drag and into the rut.

This drag seemed to do better work than the ordinary split log drag. In order to stand severe usage, it could be put together more securely than this one was, as this one was only nailed together with spikes. However, it stood the rough usage which was required of it. The planks on top were placed there for the teamster to ride on for additional weight as the condition of the road required. The drag usually did good work with the teamster's weight, and made a good load for one team of horses. For hard roads an iron or steel strip should be fastened on the inside of the 3-in. by 12-in. pieces so as to protect the wood pieces from wear and to serve as a better cutting edge.

Tree Planting Along State Roads in Massachusetts.—During the last 11 years the Massachusetts Highway Commission has planted 27,045 trees on the borders of state highways. Some years ago the Commission adopted the policy of planting quick growing trees and hedges to replace guard rails.

Methods Employed by the Wisconsin Highway Commission in Making Condition Survey of State Trunk Highways

By A. R. HIRST,

State Highway Engineer.

The statute enacted by the Wisconsin Legislature of 1917 providing for the co-operation of the State with the Federal Government in the construction of Federal aid roads requires that the State Highway Commission shall select a system of State trunk highways to which the Federal aid construction shall be confined. The system is required to connect all county seats, and all cities with a population of 5,000 or more. After May 1, 1918, the counties are required to maintain the entire system, the unimproved portions as well as the portions which have previously been improved under the State highway law or otherwise. The cost of construction and maintenance is to be paid from the proceeds of automobile licenses. All construction will be administered by the State Highway Commission direct. The maintenance will be administered by the counties under the direction of the State Highway Commission and paid for by the State. Effective control is guaranteed by a provision in the law authorizing the State Highway Commission to withhold payment for work improperly done.

The law requires that this system shall be selected prior to Nov. 1, 1917. As the law did not become effective until July 11, any ordinary methods of surveying these routes could not possibly cover the ground within the required time. A system has been devised which, it is believed, gives the required information with a minimum of expense and a maximum of speed. The information desired is such as will enable intelligent estimates of the cost of future construction and maintenance and proper comparisons between alternate or competing routes to be made. The surveys are, in effect, reconnoissances; all future construction will be based on proper instrument surveys.

All mileage measurements are made by automobile speedometer. The survey force consists of two men, an observer who also drives the car, and a recorder. The notes are taken on a specially devised blank, and are recorded by means of a code system.

Prior to beginning the survey, all speedometers to be used were carefully checked against a measured distance. The variations ranged from a few feet to more than 200 ft. per mile. It was found that these errors were caused by slight variations in the sizes of the tires of the car, and they were corrected by the use of tires of exact diameter.

A specimen of the record sheet is shown in Fig. 1 and the code is given in Table I. The record sheet is ruled horizontally into 28 spaces, one for each subject on which information is desired, and vertically into 10 spaces, each representing one-tenth mile. The subjects are arranged so that related subjects occur together, thus making the record come in a logical order, facilitating both the record and reading of the notes. The record is made almost entirely by numbers, it having been found that figures can be recorded more rapidly than letters. The record is made while the car is in motion except for stops which are made to measure culverts or bridges, and stops at the end of each mile to fill in the title blanks

TABLE I.—SYMBOLS TO BE USED ON CONDITION SURVEY OF STATE TRUNK HIGHWAYS.

1\. A. **Type.**
1—Earth.
2—Sand-clay.
3—Shale.
4—Gravel.
5—Gravel-surface treated.
6—Stone macadam.
7—Stone macadam-surface treated.
8—Bit. macadam.
9—Concrete.
10—Bit. concrete.
11—Asphalt.
12—Brick.
13—Other—give name.

1\. B. **Condition.**
1—Good; 2—Fair; 3—Poor; 4—Rebuild immediately.

2\. A. **Soil.**
1—Heavy clay; 2—Light clay or loam; 3—Sand; 4—Marsh.

2\. B. **Drainage.**
1—Good; 2—Fair; 3—Poor; 4—None whatever;
5—Center lower than ditch line.

3\. **Special Conditions.**
1 Mud hole; 2—Rock outcrop; 3—Present cut;
4—Present fill; 5—Side hill; 6—Dangerous ditch.

4 **Traveled Way—Surfacing.**
Insert in order estimated width of traveled way and surfacing as 18′-9′.

5 **Between Ditches—Fences.**
Insert in order, estimated width between ditches and between fences as 24′-48′.

6\. **Wooden Bridge—Culvert.**
1—Good, 2—Fair; 3—Poor; 4—Rebuild immediately.

7\. **Stone Bridge—Culvert.**
1—Good; 2 Fair; 3—Poor; 4—Rebuild immediately.

8\. **Steel Bridge—Culvert.**
1—Good; 2 Fair; 3—Poor; 4 Rebuild immediately.

9\. **Concrete Bridge—Culvert.**
1—Good; 2—Fair; 3—Poor; 4—Rebuild immediately.

10\. **Additional Bridge—Culvert.**

11\. **Number Spans—Opening—Clear Roadway.**
Give number of spans, size of opening, and width of clear roadway.

12\. **Floor—Floor to Stream Bed.**
1—Concrete. 1—Good.
2—Creosote Blocks. 2—Fair.
3—Plank. 3—Poor.
4—Rebuild immediately.
Give distance from floor to stream bed.

13\. **Foundations.**
1—Wooden piles. 1—Good.
2—Stone Masonry. 2—Fair.
3—Steel tubes. 3—Poor.
4—Concrete. 4—Rebuild immediately.

14\. A. **Intersecting Roads.**
1—State trunk. 1—Right.
2—State aid system. 2—Left.
3—Town road. 4—Four corners.
5—Five corners.

14\. B. **Traffic.**
1 Heavy; 2—Medium; 3—Light.

15\. **Turn-Angle (In degrees right and left from foresight).**
1—Right; 2—Left.

16\. **Vision Danger.**
1—Good. 1—Safe.
2—Fair. 2—Medium.
3—Poor. 3—Dangerous.

17\. **Possible Relocations.**
1—Right; 2—Left.
Show limits of and estimate distance increased or diminished.

18\. **Railway and Street Railway Crossings.**
Locate thus with angle //.
1—Grade. 1—Good. 1—Safe.
2—Overhead. 2—Fair. 2—Medium.
3—Undergrade. 3—Poor. 3—Dangerous.
4—Reb. immed.

19\. **Railways and Street Railways, Within Right of Way.**
Locate thus ....
1—Right. 1—Safe.
2—Left. 2—Medium.
3—Center. 3—Dangerous.

20\. **Government Limits.**
Locate town, village, city and county limits. Name central point in village or city. Also attach plat or map showing streets on Trunk System.

21\. **City Construction Limit.**
Locate limits where in your judgment construction should stop as per Federal Act.

22\. **R. F. D. Boxes—Trail.**
1—Right; 2—Left.
Note trail followed, if any.

23\. **School House—Town Hall.**
S—School house. 1—Right.
H—Town hall. 2—Left.

24\. **Church—Factory.**
C—Church. 1—Right.
F—Factory. 2—Left.

25\. **Farm Residence—Cemetery.**
Cem.—Cemetery. 1—Right.
R—Farm residence. 2—Left.
Write owner's name in each mile.

26\. **1917 State Aid Work.**
Locate as near as possible all construction for which funds are available.

27\. **Miscellaneous.**

28\. **Location of Materials.**
Give location of local materials available for construction and maintenance.

29\. **Remarks.**
Describe any difficult construction feature, extremely dangerous point, or other matters of interest.

at the top of the sheet and make estimates of maintenance and imperative construction. All widths of right of way, distances between ditches, widths of traveled way and surfacing are estimated.

The title of the specimen sheet shows the location of the road and mile under survey. The mile begins with a gravel road in good condition which continues to the end of the fifth tenth, where there is an earth road in medium condition which continues for one-tenth, where it becomes poor and continues so to the end of the nine-tenth, where a gravel road in poor condition begins and continues to the end of the mile. The soil for the entire mile is a light clay. Drainage good. The road follows the surface of the ground all the way. The width of traveled way at the beginning is 24 ft., the surfacing is 15 ft. This continues to the center of the second tenth where the traveled way and surfacing narrow to 20 ft. and 9 ft., respectively, and so continuing to the end of the fifth tenth. The last five-tenths have a traveled way of 18 ft.

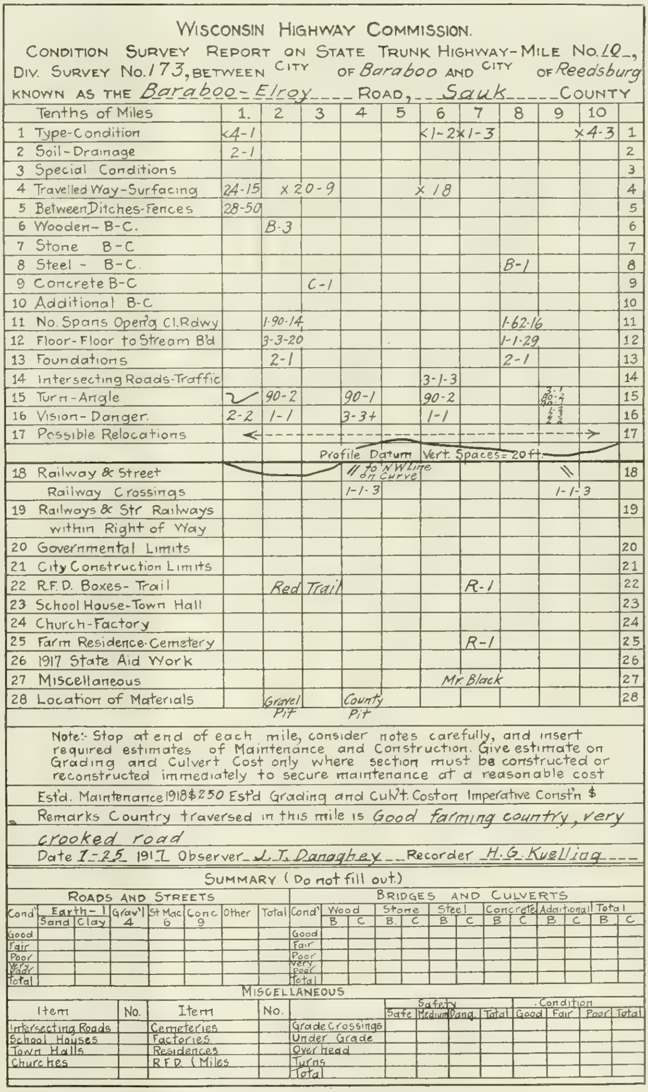
In the second tenth there is a wooden bridge consisting of a single span of 90 ft. 14-ft. roadway. The floor is of planks in poor condition; distance from grade to stream bed 20 ft. The foundations are of stone in good condition. In the third tenth there is a concrete culvert in good condition, size 2 ft. x 2 ft. x 24 ft. long. In the eighth tenth is a steel bridge in good condition, a single span of 62 ft., 16-ft. roadway. The floor is reinforced concrete in good condition; distance from grade to stream bed 29 ft. The foundations are stone in good condition.

A town road, carrying light traffic, turns off to the right in the sixth tenth. This mile is crooked at the beginning. A tortuous curve, medium vision, reasonably safe, is shown in the first tenth. In the second tenth there is a 90° turn to the left, good vision; in the fourth tenth a 90° turn to the right, poor view, exceedingly dangerous; and in the sixth tenth another 90° turn, this time to the left, good view, safe. In the ninth tenth there are three turns; 3° to the right, good view, medium safe; 80° to the left, medium view, dangerous; and 90° to the right, medium view, medium safe. An advantageous relocation of the entire mile is possible.

In the fourth tenth there is a dangerous grade crossing with the C. & N. W. Ry. The physical condition of the crossing is good. The same thing occurs again in the eight tenth. Evidently the purpose of the suggested relocation is to avoid these two crossings. In the seventh tenth a mail box belonging to Mr. Black, whose residence is on the right-hand side of the road, is noted. This indicates that the road is a mail route and thus eligible to Federal aid.

It is estimated that this mile can be maintained in reasonably good condition in 1918 for $250, without any additional grading or culvert construction.

After the survey is complete, a summation of the total number of miles is made. To insure uniformity, estimates of maintenance costs are made from a schedule of estimated maintenance costs for each type and condition of road. These range from $35 per mile for 18-ft. concrete roads in first class condition, $150 per mile for earth roads in third class condition to $450 per mile for 9 ft. macadam surfacing in third



WISCONSIN HIGHWAY COMMISSION.

CONDITION SURVEY REPORT ON STATE TRUNK HIGHWAY-MILE No. 10,
DIV. SURVEY No. 173, BETWEEN CITY OF Baraboo AND CITY OF Reedsburg
KNOWN AS THE Baraboo-Elroy ROAD, Sauk COUNTY

Tenths of Miles	1.	2	3	4	5	6	7	8	9	10	
1 Type-Condition	<4-1					<1-2	x1-3			x4-3	1
2 Soil-Drainage	2-1										2
3 Special Conditions											3
4 Travelled Way-Surfacing	24-15	x 20-9				x 18					4
5 Between Ditches-Fences	28-50										5
6 Wooden-B-C.		B-3									6
7 Stone B-C											7
8 Steel - B-C.								B-1			8
9 Concrete B-C			C-1								9
10 Additional B-C											10
11 No. Spans Open'g Cl. Rdwy		1-90-14						1-62-16			11
12 Floor-Floor to Stream B'd		3-3-20						1-1-29			12
13 Foundations		2-1						2-1			13
14 Intersecting Roads-Traffic						3-1-3					14
15 Turn-Angle		90-2		90-1		90-2			3-1 80-2 90-1		15
16 Vision-Danger.	2-2	1-1		3-3+		1-1			1-2 2-3 2-2		16
17 Possible Relocations	←- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - →	17
			Profile Datum			Vert. Spaces = 20 ft.					
18 Railway & Street				// to NW Line on Curve					\\		18
Railway Crossings				1-1-3					1-1-3		
19 Railways & Str Railways											19
within Right of Way											
20 Governmental Limits											20
21 City Construction Limits											21
22 R.F.D. Boxes-Trail		Red	Trail				R-1				22
23 School House-Town Hall											23
24 Church-Factory											24
25 Farm Residence-Cemetery							R-1				25
26 1917 State Aid Work											26
27 Miscellaneous							Mr. Black				27
28 Location of Materials		Gravel Pit		County Pit							28

Note:- Stop at end of each mile, consider notes carefully, and insert required estimates of Maintenance and Construction. Give estimate on Grading and Culvert Cost only where section must be constructed or reconstructed immediately to secure maintenance at a reasonable cost

Est'd. Maintenance 1918 $250 Est'd Grading and Culv't. Cost on Imperative Const'n $

Remarks Country traversed in this mile is Good farming country, very crooked road

Date 7-25 1917 Observer J. T. Danaghey Recorder H. G. Kuelling

SUMMARY (Do not fill out.)

ROADS AND STREETS

Cond'	Earth-1		Grav'l 4	St Mac 6	Conc 9	Other	Total
	Sand	Clay					
Good							
Fair							
Poor							
Very Poor							
Total							

BRIDGES AND CULVERTS

Cond'	Wood		Stone		Steel		Concrete		Additional		Total	
	B	C	B.	C	B	C	B	C	B	C	B	C
Good												
Fair												
Poor												
Very Poor												
Total												

MISCELLANEOUS

Item	No.	Item	No.		Safety				Condition			
					Safe	Medium	Dang.	Total	Good	Fair	Poor	Total
Intersecting Roads		Cemeteries		Grade Crossings								
School Houses		Factories		Under Grade								
Town Halls		Residences		Over head								
Churches		R.F.D. (Miles		Turns								
				Total								

Fig. 1—Report Sheet for Condition Survey.

class condition. The profile shown is intended to indicate only in a very approximate way the true ground level, and is plotted from observations of rise and fall made by the observer, assisted by a gradiometer attached to the body of the car. The elevation is taken as zero at the beginning of each mile. No attention is given to light grades of 1 per cent or 2 per cent or to the very short grades of anything less than 6 per cent. The profile indicates whether the road is smooth, rolling or rough. The information noted is supplemented by photographs. Each party carries a camera and has instructions to photograph sections of road typical of the mile traversed, also any particular dangerous situation. These photographs are attached to the mile sheet on which they occur.

The work is practically completed, the selection of the 5,000-mile system requiring condition surveys of about 7,500 miles of road. The cost is $1.20 per mile. The results are very satisfactory for the purpose intended, and it is doubtful if any more complete information could be secured in any other way except at greatly increased costs.

Maintenance Cost of Bituminous Macadam and Bituminous Concrete at Portland, Me.

Several sections of the state highway system of Maine lie within the limits of Portland, and are maintained by that city. The following data on this work are abstracted from the recently issued report of Edward M. Hunt, Commissioner of Public Works:

Section 1 of the highway is located on Danforth and Vaughan Sts., between St. John and Bowdoin Sts. It is 2,879 ft. in length and contains 8,657 sq. yd. The pavement, a bituminous macadam, was completed in 1908 at a total cost of $9,746, or $1.13 per square yard. Section 2 is located in Vaughan St., between Bowdoin and Congress Sts. The surfacing on this section is bituminous concrete. It covers a length of 2,683 ft. and a yardage of 8,807. It was completed in 1909 at a cost of $9,068, or $1.03 per square yard. Section 3 is located on Cumberland Ave., between High and Elm Sts. This also is a bituminous concrete pavement. Its total length is 1,702 ft. and its yardage is 6,398. It was completed in 1910, the total cost being $8,434, or $1.31 per square yard. The maintenance cost of these pavements has been as follows:

SECTION 1—BITUMINOUS MACADAM.

Date.	Repairs.	Surface treatment.	Total maintenance.	Maintenance per sq. yd.
1908	....	....	....	....
1909	$ 90.00	....	$ 90.00	$0.0104
1910	293.12	$306.88	600.00	0.0691
1911	69.50	246.04	315.54	0.0363
1912	72.38	157.77	230.15	0.0266
1913	95.76	96.96	192.72	0.0223
1914	98.13	100.58	198.71	0.0229
1915	60.87	126.90	187.77	0.0217
1916	105.72	....	105.72	0.0122

SECTION 2—BITUMINOUS CONCRETE.

Date.	Repairs.	Surface treatment.	Total maintenance.	Maintenance per sq. yd.
1909	....	....	....	....
1910	$ 332.67	....	$ 332.67	$0.0378
1911	99.86	$406.75	506.61	0.0575
1912	1,340.54	66.35	1,406.89	0.1597
1913	1,055.03	37.31	1,092.34	0.1240
1914	98.02	152.07	250.09	0.0284
1915	50.40	208.49	258.89	0.0294
1916	....	....	....	....

SECTION 3—BITUMINOUS CONCRETE.

Date.	Repairs.	Surface treatment.	Total maintenance.	Maintenance per sq. yd.
1910	....	....	....	....
1911	$104.98	$447.28	$552.26	$0.0863
1912	449.38	....	449.38	0.0702
1913	761.41	....	761.41	0.1190
1914	312.64	165.15	477.79	0.0747
1915	292.78	113.51	406.29	0.0635
1916	256.75	109.93	366.68	0.0573

Comparative Costs of Oregon Pavements

Last June a committee was appointed from the membership of the Oregon Society of Engineers for the purpose of obtaining comparative costs of constructing the pavements that have been most frequently used in Portland and throughout Oregon in the last 5 or 6 years. The report of the committee was submitted in July, and is printed in the October Journal of the Society, from which the matter following is taken:

Costs of Bitulithic Redress and Asphaltic Concrete Redress.

The first portion of these costs dealing with the cost of materials and of labor, both at the paving plant and on the street, is based upon daily cost records kept by the Bureau of Standards of the City of Portland in 1915 and 1916 involving the laying of 24,842 sq. yd. of 2-in. bitulithic wearing surface and 19,050 sq. yd. 2½-in. asphaltic concrete.

	Bitulithic redress, 2-in. thick. Per sq. yd.	Asphaltic concrete, 2½-in. thick. Per sq. yd.
Materials—		
Asphaltic cements at $10.50 per ton	$0.128	$0.147
Sand at $0.45 per cu. yd	0.018	0.022
Rock screenings at $0.93 per cu. yd	0.032	0.081
Portland cement	0.000	0.001
Crushed rock at $0.93 per cu. yd	0.038	0.000
	$0.216	$0.251
Mixing Plant Costs—		
Labor	$0.034	$0.042
Fuel oil ($1.10 per bbl.)	0.019	0.027
Lubricating oil	0.0007	0.0007
Power	0.003	0.003
	$0.0567	$0.0727
Haul (average of 3 miles)	$0.061	$0.076
Street Costs—		
Labor	$0.0430	$0.057
Coal for roller ($6 per ton)	0.0005	0.004
Coal oil at $0.10 per gal	0.0004	.....
	$0.0439	$0.061
Total for materials and labor	0.38	$0.46
Overhead—		
Maintenance and repairs to plant and equipment	$0.02	$0.02
Depreciation and obsolescence of plant and equipment (20 per cent)	0.0462	0.0462
Interest on plant and equipment at 6 per cent	0.014	0.014
Supervision and office expense	0.065	0.065
Taxes and use of plant site	0.037	0.037
Insurance	0.003	0.003
Total superintendence and overhead	$0.185	$0.185
Total for pavement	$0.565	$0.645

The cost allowance of $0.02 per square yard for maintenance and repairs to plant is based upon the actual guarantee that manufacturers of certain paving plants are willing to make on their plants for a moderate amount of paving. The cost factor for depreciation and obsolesence is based upon plant and equipment valued at $15,000 and upon a yearly output of 65,000 sq. yd., which was the output of the the contractors' (Giebisch & Joplin) plants in 1915 when paving in Portland was far less in quantity than for several prior years and when the Giebisch & Joplin plant had far less work than the plants engaged on the Multnomah County paving. This plant running at maximum capacity could lay this amount of pavement wearing surface in two months. During the past 10 years 6,000,000 sq. yd. of bituminous paving have been laid in Portland and Multnomah County so the average for the six plants operating during that time has been 100,000 sq. yd. per year per plant.

The factor of 20 per cent for depreciation, which is based on the allowance made for depreciation on the District of Columbia paving plant, is liberal, for the Warren Bros. Co. use a factor of 10 per cent depreciation on their plants.

The cost of supervision and office expense is based upon the following force: A superintendent at $2,400 per year, one bookkeeper at $1,200 per year and a stenographer at $600. This force is considered as working throughout the entire year and devoting all its attention to paving, though in actual practice a force of this kind handles many other contract items than paving in a year's work.

The cost item of taxes and use of plant site is based upon the payment of a rental of $200 per month for a plant site. This is a far higher rate than probably any of the plants in Portland pay.

The cost of scarifying the old macadam surface and rounding off the shoulders with crushed rock is generally bid on separately and seldom exceeds $0.10 per square yard.

Cost of Laying Bitulithic and Asphaltic Concrete on a Crushed Rock Base.

When a 2-in. bitulithic wearing surface like that described above is laid upon a crushed rock base which has been thoroughly compacted to a thickness of 4 in., we have what is known as standard bitulithic pavement. The asphaltic concrete wearing surface is also laid upon a similar base. The cost of laying such a crushed rock base by spreading a layer of crushed rock 6 in. thick and rolling it to a final thickness of 4 in. varies from $1.50 to $2 per cubic yard.

Inasmuch as the rock is paid for as measured loose before compacting, this means a cost of from 25 to 35 ct. for the crushed rock base. The cost then of a standard bitulithic pavement and of an asphaltic concrete pavement on a crushed rock base is as follows:

Standard Bithulithic—	Per sq. yd.
2-in. wearing surface	$0.565
4-in. crushed rock base	0.29
Total cost	$0.855
Asphaltic Concrete on Crushed Rock Base—	Per sq. yd.
2½-in. bituminous top	$0.645
4-in. crushed rock base	0.29
Total cost	$0.935

Cost of Laying Bitulithic and Asphaltic Concrete on a 5-In. Concrete Base.

The bituminous wearing surfaces are often laid upon a 5-in. concrete base, which under the standard specifications of the city of Portland is composed of 1:3:6 mixture.

The cost of laying such a base is about as follows:

	Per sq. yd.
Cement, 0.147 bbl. at $2 per bbl.	$0.294
Sand, 0.075 cu. yd. at $0.50 per cu. yd.	0.038
Gravel, 0.15 a yd. at $0.50 per cu. yd.	0.075
Hauling (average of 3 miles at $0.14 per ton-mile)	0.126
Rolling and sprinkling sub-grade	0.010
Forms	0.008
Mixing and placing on basis of $0.75 per cu. yd.	0.100
Sprinkling and curing	0.020
Maintenance and repairs to plant and equipment	0.010
Depreciation and interest on equipment	0.003
Supervision and office expense (covered under bituminous wearing surface)	0.000
Insurance	0.005
	$0.690

Hence the total cost of bitulithic or asphaltic concrete laid on a concrete base is about as follows:

Bitulithic or Concrete Base—	Per sq. yd.
2-in. wearing surface	$0.565
5-in. concrete base	0.69
Total	$1.255
Asphaltic Concrete—	
2½-in. bitulithic top	$0.645
5-in. concrete base	0.690
Total	$1.335

Cost of Concrete Pavements.

Two different types of concrete pavement are in vogue in Portland and vicinity. In Portland a concrete pavement 6 in. thick, 1-2-4 mix without expansion joints is laid under the city specifications, while on the Multnomah County Highway work in 1915 a pavement 6 in. thick consisting of a 1-1½-3 mix with armored expansion joints was laid.

The cost of the 1-1½-3 armored concrete is about as follows:

Materials—	Per sq. yd.
Cement, 0.317 bbl. at $2 per bbl.	$0.634
Sand, 0.081 cu. yd. at $0.50 per cu. yd.	0.041
Crushed rock, 0.16 cu. yd. at $1 per cu. yd.	0.160
Expansion joints	0.040
Total materials	$0.875
Hauling (average of 3 miles at $0.14 per ton-mile)	$0.130
Rolling and sprinkling sub-grade	0.010
Forms	0.010
Mixing and placing at $0.75 per cu. yd.	0.120
Sprinkling and curing	0.040
Maintenance and repairs to equipment	0.010
Depreciation and interest on equipment	0.003
Supervision and office expenses	0.065
Insurance	0.005
Total	$1.268

The cost of the 6-in. 1-2-4 concrete pavement without expansion joints as laid by the city of Portland is about as follows:

Materials—	Per sq. yd.
Cement, 0.248 bbl. at $2 per bbl.	$0.496
Sand, 0.075 cu. yd. at $0.50 per cu. yd.	0.038
Crushed rock, 0.15 cu. yd. at $1 per cu. yd.	0.150
Total materials	$0.684
Hauling (average 3 miles at $0.14 per ton-mile)	0.130
Rolling and sprinkling sub-grade	0.010
Forms	0.010
Mixing and placing at $0.075 per cu. yd.	0.120
Sprinkling and curing	0.030
Maintenance and repairs to equipment	0.010
Depreciation and interest on equipment	0.003
Supervision and office expense	0.065
Insurance	0.005
Total cost	$1.067

Engineers Wanted by Tennessee State Highway Department

The Tennessee State Highway Department will hold an examination on Nov. 19, 1917, for assistant highway engineers. In compliance with a recent law enacted by the Legislature, highway engineers cannot be employed by the State until they have first passed a creditable examination before the Examining Board, composed of the State Highway Engineer, the Dean of Engineering, University of Tennessee, and the State Geologist. The object of this examination is to qualify engineers that they may be selected for highway work in connection with the Federal and State aid projects within the state. The State contemplates the employment of about 10 or 12 additional engineers immediately for this work. There will also be other positions open, such as instrument men, rodmen and chainmen to fill up these 10 or 12 parties, for which there is no examination required other than the applicant will be required to show his fitness for the position for which he applies.

The State Highway Department is now preparing a number of projects to be passed upon by the Federal Government with an idea of immediate construction, and has ordered that the unimproved portions of the Memphis-to-Bristol Highway (610 miles in length) and the Dixie Highway (207 miles in length) be immediately prepared as the first projects to be improved under the Federal and State Aid System. Any information concerning these positions or the work may be obtained by addressing Mr. A. M. Nelson, State Highway Engineer, Nashville, Tenn.

Cement Saved by Using Screened and Remixed Gravel Instead of Pit Run Gravel

By JAS. P. NASH,

Testing Engineer, Road Materials Laboratory, University of Texas.

While opinion among engineers seems pretty well crystallized regarding the value of screening and remixing pit-run gravel to obtain a more satisfactory concrete from the standpoint of strength and uniformity, there seems to be considerable difference of opinion regarding the actual economy of this. The specifications of many cities require that the base for the paving should be of 1:7 concrete, using pit-run gravel as the aggregate. In most cases specifications were written under the impression that this obtains as strong concrete as a 1:3:6 mix at less cost. Below are given two curves to show the fallacy of this.

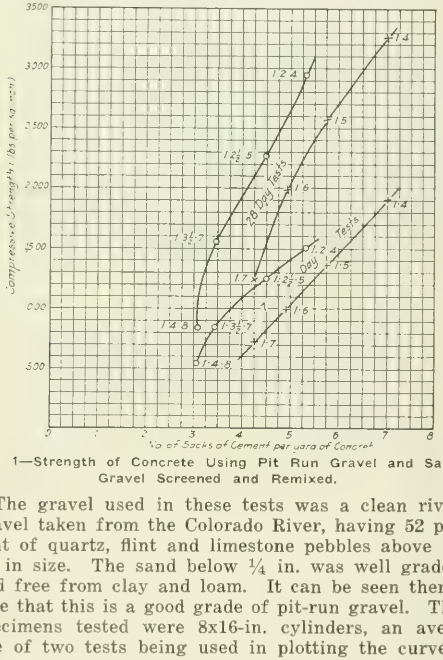


Fig. 1—Strength of Concrete Using Pit Run Gravel and Same Gravel Screened and Remixed.

The gravel used in these tests was a clean river gravel taken from the Colorado River, having 52 per cent of quartz, flint and limestone pebbles above ¼ in. in size. The sand below ¼ in. was well graded and free from clay and loam. It can be seen therefore that this is a good grade of pit-run gravel. The specimens tested were 8x16-in. cylinders, an average of two tests being used in plotting the curves. The sand (material under ¼ in.) and the coarse aggregate (pebbles over ¼ in.) used in the re-proportioned mixes were obtained by screening the pit-run gravel through the ¼-in. sieve. The concrete made from the 1:3:6 mix showed lower strength than the 1:3½:7 mix and was eliminated from the curves as it was manifestly an error. This low strength was due, it is believed, to the fact that this mix was made from the remaining portion of the aggregate and had accumulated more large stones than it should have had.

From the curves in Fig. 1 it may be seen that the 1:5 mix and the 1:2:4 mix require practically the same amount of cement per yard of laid concrete, while the concrete made from the latter developed about 15 per cent greater strength. The 1:2½:5 mix produced concrete having 14 per cent more strength than the 1:6 mix in spite of the fact that the latter requires 0.4 sacks more cement to a yard of laid concrete than the former. In the concretes having less cement the difference is more apparent. The 1:3½:7 mix obtains a stronger concrete than the 1:7 mix, while the latter required 0.8 sacks more cement to the yard of concrete than if the materials had been screened and remixed 1 part cement, 3½ parts sand and 7 parts screened gravel.

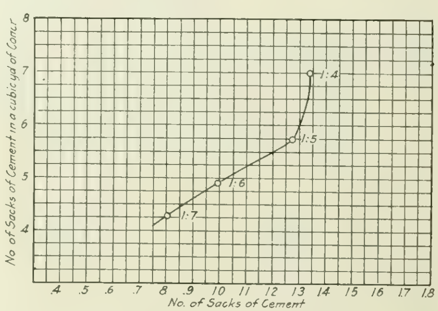


Fig. 2—Amount of Cement Saved by Screening and Remixing Gravel, Keeping Proportion of Cement and Gravel the Same, But Adding to the Screened Gravel ½ as Much Sand.

The curve in Fig. 2 shows the amount of cement that was saved by screening the gravel through the ¼-in. sieve and remixing in the proportions of half as much sand as screened gravel. In other words, the curve shows that the pit gravel used to make the 1:7 mix, when screened and remixed in the proportions of 1:3½:7, requires 0.8 sacks less cement to make a cubic yard of concrete. This is in spite of the fact that the latter shows a 20 per cent increase in strength.

It seems very probable that if these tests were carried out, using various grades of pit-run gravel, it would be found that a point would be reached where the amount of sand in the pit-run gravel would be so small that it would not prove economical to screen and remix the aggregates. This probably would be a gravel containing close to 35 per cent sand. Most of the natural gravels, however, tend toward the other extreme and in many natural gravels there are but 40 per cent of pebbles over ¼ in., so the curves given here are conservative rather than otherwise.

In the table are given the amounts of material required to make a cubic yard of concrete using this gravel, which should be approximately correct for any gravel having the same proportion of sand and coarse aggregate. It is believed that the amount of pit-run gravel or screened gravel required for a cubic yard of concrete will be but little different even though the proportion of sand in the pit-run gravels vary considerable. The saving in cement, however, would be greater in direct ratio with the amount of sand in the pit-run gravel.

AMOUNT OF MATERIALS REQUIRED TO MAKE 1 CU. YD. OF CONCRETE.

(Pit run gravel having 52% material over ¼ in. and 48% of sand passing the ¼-in. sieve.)

Proportion of concrete.	Gravel used cu. yd., per cu. yd. of concrete.	Sand used, cu. yd., per cu. yd. of concrete.	Cement, sacks, per cu. yd. of laid concrete.	Saving of cement by using screened material. No. of sacks.
1:8	.91	.455	3.06	...
1:7	1.10	....	4.25	...
1:3½:7	.89	.445	3.44	.81
1:6	1.09	....	4.91	...
1:3:6	.87	.435	3.92	.99
1:5	1.07	....	5.76	....
1:2½:5	.83	.415	4.48	1.28
1:4	1.04	....	7.01	...
1:2:4	.84	.42	5.67	1.34

Considerations Governing the Choice of Various Types of Road Construction

The various factors controlling the selection of type of road construction were outlined in a general way in a paper presented at the recent joint meeting of the County Commissioners and County Engineers of the State of Washington by L. V. Edwards, Professor of Highway Engineering at Washington State College. An abstract of the paper follows:

When any highway improvement is undertaken the object to be sought is to select the type of construction which will serve the traffic to be carried at the lowest annual cost per unit. To make that statement clear it must be kept in mind that the three main items of expense of a road surface are first cost, maintenance cost, and interest on the money invested. These are all variables and, with the exception of the interest rate, depend upon local condition. The problem, therefore, resolves itself into a study of local conditions, which, with a knowledge of the characteristics and the traffic-resisting qualities of the several kinds of surface, make it possible to select that type of construction which will at least approximately serve the traffic at a minimum cost.

When considering the type of road to be built there is no question but what, in many cases, too much weight is given to the first cost of construction and not enough to maintenance costs and other considerations. The tendency has been to select the cheapest road, with the hope that maybe it will prove to be the best. The great demand for as much mileage of improved highway as it is possible to get with the amount of money available, even though it may be second rate, undoubtedly has had much to do with the selection of unsuitable surfaces. Many, however, are now beginning to realize that it is the poorest sort of economy to spend two-thirds enough money constructing a surface that immediately fails, thus requiring excessive maintenance work if the highway is to be kept in passable condition, as would be required to construct a different kind which would have sufficient strength and durability to carry the traffic with only a small annual cost for maintenance.

As has just been pointed out, for economical results, maintenance, interest and the volume of traffic must be considered. It is evident, therefore, that there is no type of construction that will give economic results under all conditions. The type of road costing $15,000 per mile may be more economical in one case, while in another case traffic may be so light that $1,000 per mile would be the proper amount to expend. If all the different roads in a county were surfaced with the proper type in each case, to give the least annual cost per unit of traffic, there would necessarily have to be many different kinds in use to satisfy the variable conditions. There would probably have to be a large mileage of earth, gravel and macadam, as well as of the more durable types, such as bituminous concrete and brick. A point to be noted is that with such a system the annual cost per unit of traffic would be the same on the earth or gravel as it would be on the bituminous concrete or brick.

It has already been intimated that local conditions are the important things that must be studied before it is possible to decide upon the correct type of construction in any given case. A study must be made of the climatic conditions; the effect of moisture and frost action on the subgrade—in other words, drainage; the quality and availability of road building materials; the kind and amount of traffic, etc. These not only have a bearing on the first cost, and therefore the selection of the proper type, but also affect or control the design of the type that is to be used.

Highway engineers probably commit more sins on account of insufficient knowledge of subgrade conditions than on any other part of the work. One of the things that must be studied to obtain a proper knowledge of the conditions is the nature of the soil in the subgrade from one end of the improvement to the other. This would probably involve a determination of the approximate amount of mineral matter present and the effect that water and frost would have on this material. The engineer must know the topography of the locality and the laws governing the flow of both surface and underground water to be able to know what effect these will have on the finished roadway. He must also know the supporting power of the subgrade at least at the points where it is weakest in order to design a surface that will be sufficiently strong to carry the road over these places. The supporting power of any subgrade, no matter what care has been taken in its preparation, is a very variable quantity. It is therefore not to be wondered at that when miles of pavement, having a uniform thickness, which means also uniform strength, is placed on this unequal support, parts of the pavement fail while other parts remain good. Think of the money that could be saved if engineers knew enough to vary the thickness of the surfaces during construction, within the proper limits, to take advantage of this unequal supporting power.

Traffic is one of the main factors that must be considered in the selection of a type of surface. The importance of the need of knowing at least the approximate amount of traffic that our highways are carrying cannot be overestimated. It does not seem reasonable that one would undertake to build a structure to perform a certain service when he knows nothing, or practically nothing, about the nature of the service to be performed. This, however, is being done every day in highway work. Owing to the large number of variables which influence the volume of traffic that any highway may have, a considerable amount of investigation has to be made before it is possible to make a reliable estimate of the daily or annual traffic that any road may have during its life. Fortunately, however, to serve a good purpose in determining the type of road to construct, it is not necessary that an exact knowledge of the traffic to be served be known. If the traffic estimated is within 50 per cent of the correct amount this would be a great deal better than knowing nothing about it at all, as is so often the case at the present time.

The best way, of course, to find out the traffic any road is carrying is to make a count or take a traffic census. To get absolutely correct results would require that a count be made every day in the year, but sufficiently reliable results can be obtained if the count is taken for 10 to 14 hours every 3d, 5th or 13th day throughout the year, or at less frequent intervals if the importance of the road did not justify it. A splendid idea of the relative importance of the several roads in a county can be had by taking as little as one count extended over a period of 2 or 3 days simultaneously on all the roads. Even a very little traffic data, if studied in connection with other things, will often make it possible to predict with a reasonable degree of accuracy what the traffic will be, and give a good idea of the rate of increase. Some of the things to be considered which affect the volume of traffic are: Population, assessed valuation of the property, the nature of the agricultural work, the number of autos and other vehicles in use, whether the road is a section of a trunk line highway or not, and the probable rate of increase of these conditions. For example, the rate of increase of the tributary population to the increase of volume of traffic does not vary directly with the increased tributary population, but as the square of the population, other things being equal. This means that when the population doubles the traffic on the highway will be increased four times.

Sometimes the traffic on a highway increased several hundred per cent immediately after it has been improved. This is to be expected if the tributary and parallel roads are in poor condition. This will tend to decrease when these tributary roads are improved.

When making comparisons of two different types of surfaces for the same highway several things must be considered besides the first cost and annual maintenance cost. Suppose, for example, that a bituminous concrete surface is being compared with a waterbound macadam (assuming, of course, that it would be possible to maintain a macadam surface where the traffic was heavy enough to justify a bituminous concrete surface); even though the unit cost of traffic might figure the same for the two types, the superior degree of service furnished by the bituminous concrete would be a point in its favor. Also the less rolling resistance to traffic, less damage to vehicles, particularly the tires of automobiles, and its appearance would all be points in favor of the more costly type, while the waterbound macadam would have the advantage from the standpoint of better foothold for horses. Another thing must be considered when making the comparison between the two, and that is the value of the pavement when it has reached the stage where it is necessary to reconstruct the surfaces. This residual value, as it may be called, may be as much as 75 per cent of the original cost in one case while in the other it may be practically zero. To illustrate: Suppose a bituminous concrete surface originally constructed of 3 in. of bituminous concrete on a 7-in. Portland cement foundation. At the end of 20 years, say, the bituminous portion of the pavement may have to be reconstructed, in which case it might be only necessary to clean the bituminous surface, rip it from the concrete foundation, reheat it, and add enough bituminous cement and mineral aggregate to give it the proper quality and enough volume to allow for the loss in wear, replace on the old concrete foundation and the pavement would be good for another 20 years. It is evident that this second construction would cost only a small per cent of the first.

Experienced highway engineers who know the life history of the various types of construction and their behavior under different climatic and traffic conditions are able to predict with a reasonable degree of accuracy the behavior of any type of construction when subjected to a known set of conditions. It is the adjusting of the knowledge of the different types to the local conditions so that traffic will be served at the lowest unit annual cost that solves the problems. This problem is essentially an engineering one, and is worthy of the most conscientious effort of the best trained engineers.

The Work of Massachusetts State Highway Commission in 1916

During the year ending Nov. 30, 1916, the Massachusetts State Highway Commission completed work on about 31 miles of State highway, portions of which were laid out in 1915. Construction was commenced, but not completed, on over 17 miles of roads in 18 cities and towns. Layouts were made of about 54.47 miles of State highway in 39 cities and towns. The total length of State highways at the end of the year was 1,154.98 miles. The total expenditures by the Commission for the construction of State highways since the work began (the first State-aid law was passed in 1892), including the planting of trees, amounts to $11,643,799, according to the recently published 1916 report, from which these notes are taken.

The roads completed in 1916 included 30.60 miles of State highways, 45.01 miles of highways under the provisions of the "small town" act, 39.52 miles of highways under the provisions of chapter 525 of the Acts of 1910, and 23.96 miles of highways under the provisions of special acts, making a total of 139.09 miles. Of the total, 11.22 miles were of water-bound macadam; 46.25 miles were of gravel; 3.48 miles were of sand bound with asphalt; 18.61 miles were of bituminous macadam; that is, macadam with bituminous binder incorporated in the top course; 15.04 miles were of waterbound macadam with an oil surface applied; 3.93 miles were of crushed gravel with the top surface bound with asphalt; 5.17 miles were of cement concrete; 10.93 miles were of gravel with an oil surface applied; 14.95 miles were of sand and oil, layer method; .82 of a mile of broken stone and tar, mixed; .38 of a mile was of Warrenite; .06 of a mile was of granite block on a concrete foundation; and 8.25 miles were dirt roads; that is, surfaced with the best available material.

The Commission continued its policy of the last few years of building stronger, wider roads, with much less crown on all the main lines of traffic. This policy has been followed not only in the construction of new roads, but in the resurfacing of the old ones. On main lines the hardened surface has been widened from the standard of 15 ft. a few years ago to a minimum width of 18 ft. on the straightaway, with shoulders 3 ft. in width on each side, and 21 ft. or more on the curves. All curves have been banked where possible with a pitch of from 3/8 in. to 3/4 in. to the foot of width.

On many main lines when the road has been resurfaced, it has been necessary, because of the heavy motor traffic, to put in a foundation, to make the road stronger. The Commission on these main lines has continued to build roads, using some form of bituminous construction on the top, or else it has built them of cement concrete. The materials used have varied with the estimated amount of traffic and the weight of traffic that may use the road, the material available, and other local conditions.

On the main routes it has built broken stone roads and grouted them with tar or asphaltic products, or it has used a surface made of hot gravel mixed with hot asphaltic oil.

On Cape Cod, where the traffic is usually light in weight though extensive, and sand is abundant, it has continued to construct roads made of sand heated and mixed with a hot asphaltic oil. Some of these roads constructed six or more years ago are still carrying the traffic satisfactorily.

Mixed gravel and asphalt, and sand and asphaltic oil, have been used to quite an extent on a good many miles of road, both for widening the old macadam road and for a top surface about 2 in. thick.

Where bituminous materials were used and grouted into the broken stone, and wherever heavy traffic, especially motor trucks, would probably use the road, 3-in. stone was used on the top surface, this being thoroughly rolled, and the hot bitumen sprayed in under pressure. The smaller sizes of stone were then rolled in before a surface coat was applied.

On grades, the Commission has continued in many places to grout the top course of 3-in. stone with a hot mixture of tar and sand leaving the top surface rough, hoping that it will prove less slippery for horses. It has also for the same reason omitted the bituminous surface coat in some places. This may help for a time, but the Commission fears that the road surface will eventually begin to ravel or disintegrate because of the little holes where water can penetrate the road and freeze, and that then the surface coat will have to be applied.

On main lines the Commission has more and more each year favored the building of cement concrete roads. Whenever the Commission has built concrete roads, it has made them at least 18 ft. in width, and has used a good deal of care in preparing the drainage and foundation. It is using the best quality of materials—cement, sand and stone carefully proportioned. It is building roads at least 5 in. thick on the sides and 7 in. thick in the center where conditions are good, and 6 in. in thickness on the sides and 8 in. in the center where they are not. For the last two years the Commission has been using some dehydrated lime with the cement to make a denser mixture and prevent the expansion due to moisture.

The Commission, while building stronger and more expensive roads where the traffic will be heavy, has continued its policy, especially in the western part of the State where the traffic is light in weight or consists mainly of automobiles, of trying to get the main routes widened and improved so that they can be used in safety and comfort during the summer at least. Here gravel roads have been built, where gravel was obtainable, otherwise, the best material available has been used. Every effort has been made to try to get a reasonably good road constructed, with proper drainage, good alinement, reasonable grades, and a stone or gravel foundation where necessary. This has seemed a wise policy to pursue, for if better and more expensive roads were built in one place, the construction of roads in other places would necessarily be delayed.

The first and most necessary thing to be done was to keep in as good condition as possible the existing State highways, over 1,100 miles in length. This was done by constant patching and the use of bituminous covering. The drainage also had to be kept open. On practically all State highways there were either section men or repair gangs in charge of the maintenance to keep the roads at all times in proper repair.

Bituminous materials were used during the year on practically all the State highways that had not been constructed of concrete or paved, unless recently resurfaced with bituminous materials.

The Commission used in 1910 over 3,800,000 gal. of various tar and asphalt products, either in construction or for surface treatments and patching. Much of this bitumen was used in the construction and maintenance of town roads.

During the year over 51½ miles of State highway were resurfaced, 23½ miles were widened but not resurfaced, and 40 miles were widened and resurfaced.

The total cost of this work of widening and resurfacing was over $657,000, the widening costing over $156,000.

The resurfacing alone cost over $500,000, or an average of nearly $10,000 per mile. This large expenditure was necessary, not only because of the high cost of labor and materials this year, but also because many of the roads had to be entirely reconstructed and a foundation put in as well. In several places a cement concrete road was built to replace the old macadam, making practically a new road except for the existing grading and drainage.

Ordinary maintenance includes the cost of the patching done by the section men in charge of the roads. This ordinary maintenance cost over $322,000, or about $280 a mile for the 1,155 miles of State highway. Of course, some of the newer roads required very little maintenance. The maintenance alone cost over $145,000, or about $125 a mile, and the patching alone cost over $177,000, or about $155 a mile.

Probably the first item would fairly represent the average maintenance cost on all the roads, but the cost of patching would be much above the average cost if it were figured only on the roads that really required substantial patching.

A much fairer estimate would distribute the $177,000 spent in patching alone over 700 to 800 miles of the older highways that really had to be patched, which would make the cost of patching from $220 to $250 a mile.

More than 600 miles of the older State highways were coated with light oils or cold tars. This work cost over $164,500, or an average of about $274 a mile. Most of these roads had been coated in former years, so that only a very small quantity of the bituminous material was spread on each square yard, usually from 1/5 gal. to ¼ gal. Consequently, only a small quantity of sand or gravel covering was required. On a few miles of road a larger quantity had to be used, and the expense was greater in consequence. On a few miles, where the traffic was extremely heavy, a second application was made during the season.

Taking the 700 to 800 miles of the older State highways of water-bound macadam, or gravel, or sand and oil, that were maintained by patching and by the use of some bituminous coat on the surface, the total cost of maintenance was from $620 to $650 a mile.

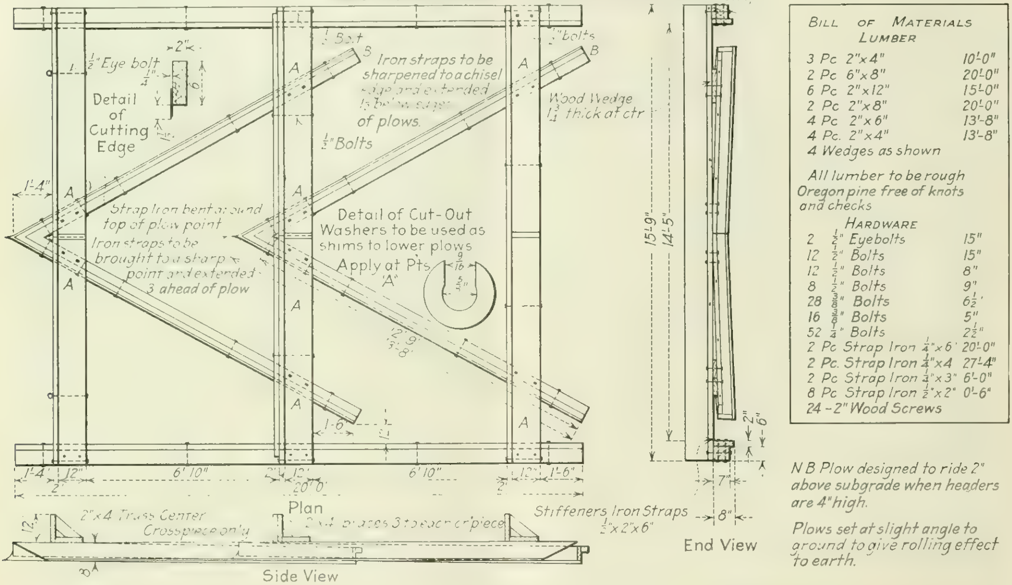
The total amount spent by the Commission for resurfacing, widening and the above maintenance was over $1,140,000. Much more money would have been spent but for the scarcity and high cost of labor. The cost of all work in 1916 was much greater than in the previous year; perhaps 25 to 35 per cent was the normal increase.

During the last 5 years the Commission has only had money enough available to resurface 251 miles of the older State highways. When this resurfacing was done, 124 miles of road were widened. During the last two years 41 miles of the old State highways were widened but were not resurfaced, making 165 miles in all that have been widened.

Finish Drag for Shaping Sub Grade

Excellent results in shaping the subgrade on State highway work in California is being obtained by use of a wooden drag. After the rough grading is finished and the headers set, the subgrade between strips is thoroughly scarified. An estimate of the amount to allow for compression after rolling is then made and the cutting edges of the drag set accordingly by the shims at "A" (see Fig. 1).

The drag is ordinarily pulled by the roller, although if desired, stock can be used. The movement of the roller forces all excess dirt to the edges at "B" (see Fig. 1) from where it is readily shoveled over the headers to be used later for covering concrete.



Iron as shown to strap-iron ¼ x 6" fastened with 2" screws ctsk 2 Ctrs
½" Eye bolt
2"
¼"
6"
Detail of Cutting Edge
1'-4"
A
B
½ Bolt
Iron straps to be sharpened to a chisel edge and extended 1½ below edge of plows.
½" Bolts
½" bolts
Wood Wedge 1¾ thick at ctr
Strap Iron bent around top of plow point
Iron straps to be brought to a sharp point and extended 3 ahead of plow
Detail of Cut-Out Washers to be used as shims to lower plows
Apply at Pts 'A'
9/16
5/8"
2' 9"
3'-8"
1'-6"
15'-9"
14'-5"
2"
6"
1'-4"
12"
2'
6' 10"
2'
12"
20' 0"
6' 10"
12"
1'-6"
7"
8"
Plan
2"x4 Truss Center Crosspiece only
2x4 braces 3 to each crpiece
12"
8"
Side View
Stiffeners Iron Straps ½"x 2"x 6"
End View
BILL OF MATERIALS
LUMBER
3 Pc 2"x4" 10'-0"
2 Pc 6"x8" 20'-0"
6 Pc 2"x12" 15'-0"
2 Pc 2"x8" 20'-0"
4 Pc 2"x6" 13'-8"
4 Pc. 2"x4" 13'-8"
4 Wedges as shown
All lumber to be rough Oregon pine free of knots and checks
HARDWARE
2 ½" Eyebolts 15"
12 ½" Bolts 15"
12 ½" Bolts 8"
8 ½" Bolts 9"
28 ⅜" Bolts 6½"
16 ⅜" Bolts 5"
52 ¼" Bolts 2½"
2 Pc Strap Iron ¼"x6' 20'-0"
2 Pc. Strap Iron ¼"x4 27'-4"
2 Pc Strap Iron ¼"x3" 6'-0"
8 Pc Strap Iron ½"x2" 0'-6"
24-2" Wood Screws
N B Plow designed to ride 2" above subgrade when headers are 4" high.
Plows set at slight angle to ground to give rolling effect to earth.

Fig. 1—Finish Drag for Shaping Subgrade Preparatory to Rolling.

The drag operates directly on the headers and has sufficient weight so that it will not easily ride when a heavy excess of material is encountered. This allows the dirt to be carried along, filling any depressions, and a uniform stretch of unrolled subgrade is the result.

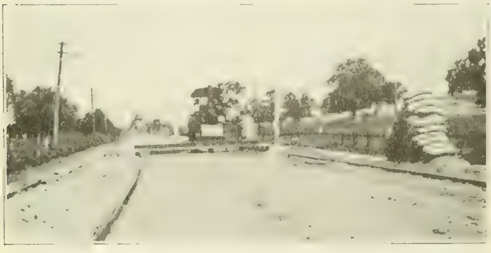


Fig. 2—Drag Operates Directly on the Headers.

The secret of success in using this method is at all times to aim for a slight excess of material, as this keeps the cutting edges full, otherwise it is necessary to stop and shovel in material from within, which is slow and expensive, and the slight cost of removing the excess dirt is balanced by availability and ease with which it can be used later for curing concrete.

Roller Method of Finishing Concrete Roads

The new specifications for concrete road construction of the Kansas State Highway Commission, of which Mr. W. S. Gearhart is State Highway Engineer, contain the following provision regarding the roller method of finishing:

> After the surface of the concrete pavement has been struck off to the proper cross section, it shall be rolled with a light hollow sheet steel roller, about 6 ft. long and 10 in. in diameter, to which a bail is attached, carrying a long handle. The roller shall weigh approximately 70 lb. and the handle shall be of sufficient length to reach entirely across the pavement. The roller shall be moved transversely across the pavement surface and rolling shall continue at intervals until little or no free water is squeezed from the concrete.
>
> After rolling, and just previous to the concrete obtaining its initial set, the surface shall be finished by drawing a belt over it with a combined longitudinal and cross-wise motion, in order to produce a uniform surface of a gritty texture, free from depressions and inequalities of any kind. Great care shall be taken to prevent rubbing hollow places in the surface.
>
> Short handled wood floats may be used as a substitute for the belt, only upon written authorization of the engineer, in which case the finishing shall be carried on from a suitable bridge, no part of which shall come in contact with the concrete. Long handled wood floats shall not be used. The belt and roller shall meet the approval of the engineer.

Three state road contracts aggregating $363,000 have just been awarded by the State Highway Commission of California. The work calls for 24 miles of concrete pavement.

Expansion and Contraction of Concrete Roads

An extended series of laboratory and field tests was begun in 1910 by the U. S. Office of Public Roads to make a close study of expansion and contraction movements of concrete pavements. These included detailed attention to the spacing, design and movement of expansion joints. The results of these experiments are presented in a recently issued bulletin prepared by Mr. A. T. Goldbeck, Engineer of Tests, and F. H. Jackson, Jr., Assistant Testing Engineer, of the U. S. Office of Public Roads. While no attempt is made in the bulletin to apply the results obtained to the practical side of road construction, certain broad conclusions are drawn that should be of particular interest to the designers.

The general discussion and the conclusions, based on expansion and contraction measurements, follow:

The laboratory and field measurements show that concrete changes in length owing to at least two separate agencies: (1) Change in moisture content and (2) change in temperature.

Change in Moisture Content.—By laboratory measurements made on large specimens it has been demonstrated that concrete changes in length from its wet condition just after setting to an extremely dry condition at six months or one year later by an amount equal to 0.0005 to 0.0006 in. per inch of length. A change of 0.0006 in. is as much as would be caused by a change in temperature of $0.06 \div 0.0000055 = 109°$ F. and would produce considerable stress under favorable conditions. This change, however, is a very slow one. It occurs most rapidly during the first few weeks of drying out and becomes very slow at the end of three months. At one year the change due to drying will have become constant in amount. It has also been seen that when concrete is kept wet it does not contract, but it expands and maintains a constant expansion of about 0.0001 in. per inch of length. Furthermore, it has been demonstrated that by subjecting hardened concrete to alternate wetting and drying its length may be changed, irrespective of temperature changes. Such moisture changes, however, are rather slow in their action, and a prolonged period of wet conditions or a prolonged period of dryness is necessary to effect a large change in the length of the concrete such as might be obtained in a very short time by the influence of temperature. When specimens are stored in the weather and subjected to rain and sunshine they change very little in length because of moisture changes, unlike specimens that are stored under prolonged conditions of extreme wetness or dryness.

In the field measurements on the Chevy Chase and Ohio Post roads, except that at Mount Sterling, Section III, it is difficult to distinguish the effects of moisture, since apparently they are overshadowed so greatly by the temperature expansion and contraction. It seems that the concrete in the road, when subjected to actual weather conditions, does not suffer the prolonged extreme ranges of moisture content suffered by the laboratory concrete specimens kept indoors in the dry air of the laboratory and therefore does not expand or contract because of moisture changes to the extent that the laboratory specimens change. Undoubtedly in warm, dry weather there will be some slight contraction just after the moisture is allowed to dry out from the concrete, particularly in a well-drained sub-base. It seems that enough of the water absorbed by the concrete, due to rains or to capillarity, remains in the concrete during the dry weather to prevent much change in length. There may be conditions of prolonged extremes of wetness and dryness in the road which will affect the expansion and contraction to an appreciable extent. Thus in the spring of the year the prolonged moisture of the previous winter might so aid the expansion occurring during the first day of high temperature that the road will heave where proper allowance has not been made for this expansion. There are also conditions of poor drainage in the sub-base, particularly in a low section of the road, where the concrete will be practically constantly saturated, in which case the expanding effect of the moisture will be in evidence.

TABLE I.—CHANGE IN LENGTH OF CONCRETE IN OHIO POST ROAD.

Section I—	Oct. 31.	Mar. 4.	June 19.	Feb. 25.
Change in temperature	—32	—52	—14	—48
Actual unit change....	—0.00017	—0.00031	—0.000064	—0 00023
Calculated temperature change	—0.000176	—0.00029	—0.000077	—0.00026
Section II—	Nov. 2.	Mar. 3.	June 17.	Feb. 25.
Change in temperature	—22	—45	+3	—38
Actual unit change....	—0.000076	—0.000227	+0.000024	—0.000168
Calculated temperature change	—0.000121	—0.000248	+0.000017	—0.00021
Section III—	Nov. 7.	Mar. 6.	June 15.	Feb.22.
Change in temperature	+3	—14	+24	—10
Actual unit change...	+0.0000096	—0.000109	—0.000148	+0.000072
Calculated temperature change	+0.0000165	—0.000077	+0.000132	—0.000055

Effect of Variations in Temperature—Field Measurements.—It has been pointed out that, as a rule, the concrete in a road expands and contracts as the temperature rises and falls. It will be interesting to compare the actual measurements of the expansion and contraction of the concrete in the road with the calculated change, assuming no friction at the base and assuming a coefficient of expansion of 0.0000055 per degree F. Table I shows a comparison of the actual with the theoretical unit changes in the concrete of the Ohio Post Road.

These comparisons of the actual change with the theoretical change, considering temperature alone to be the cause, are interesting. Observe that in Section I the agreement of the theoretical with the actual change in length is quite close, indicating that temperature was almost the sole cause of the change, and indicating, moreover, that the resisting effect of friction at the base must have been small. In Section II the agreement is not quite so close, and in Section III the agreement is poor. The actual unit change in many cases is in excess of the calculated temperature change, thus indicating that moisture is causing some expansion and also that the restraining effect of friction in preventing expansion and contraction may be quite small.

The discrepancies between the measured changes and theoretical changes are very noticeable in Section III. Section III lies at the bottom of two 6 per cent grades and the conditions are very favorable for a wet sub-base. Moreover, this section of the road was covered continually with mud tracked in from adjacent roads, and this aided in preserving the road in a moist condition. The actual change in length on June 15 and Feb. 22 was greater than the calculated change, and these days were preceded by a considerable period of wet weather. These conditions were promotive of a wet sub-base, and this probably accounts for the increase in expansion of the actual over the theoretical. On June 15 the actual expansion is 0.000148 minus 0.000132, or 0.000016. On Feb. 22 the excess unit expansion equals 0.000127 in. As shown by laboratory measurements, this is approximately the amount of expansion produced in concrete by continued moisture, and this measurement therefore tends to confirm the presumption that the moisture effect is causing the difference between the actual expansion and calculated temperature expansion. The apparently small effect of friction in preventing expansion is interesting and is not unreasonable when it is considered that the pavement is subjected to continued vibration which would tend to relieve temporarily any friction between a wet clay sub-base and the concrete. Moreover, the slow yielding of the sub-base as the concrete creeps helps to relieve the stresses of friction.

Conclusions, Based on Expansion and Contraction Measurements.

Neat cement, when allowed to dry, first contracts rapidly, then more slowly. The amount of contraction seems to vary with the cement, size of specimen, and condition of atmosphere in which drying takes place. The amount at 28 days is about 0.1 per cent and at 6 months about 0.2 per cent.

Mortar contracts on hardening in air and expands on hardening in water. The contraction in warm, dry air at 28 days is about 0.045 per cent for 1:2 and 1:3 mortar and at 6 months is 0.078 for 1:3 mortar and 0.085 for 1:2 mortar. The expansion in water is 0.01 per cent for 1:3 and 0.017 for 1:2 mortar at 28 days, and at 6 months 0.013 for 1:3 and 0.02 per cent for 1:2 mortar.

Both 1:2:4 and 1:3:6 concrete contract on drying in warm, dry air from 0.02 to 0.04 per cent at 28 days and from 0.04 to 0.07 per cent at 6 months. When hardening in water an expansion of about 0.01 per cent takes place at 28 days and 6 months in 1:2:4 and 1:3:6 concrete.

The richness of the mix of concrete seems to exert a small influence on the contraction; the richer the mix the greater the change in length.

Concrete alternately wetted and dried may be made to expand and contract owing to these causes. The expansion due to wetting is more rapid than the contraction on drying. The thoroughly dried specimens of concrete do not recover their original wet length when immersed.

Concrete stored in the outer air and exposed to the weather does not contract to the same extent as the above described specimens except under very dry conditions.

A waterproof covering, such as coal tar, prevents the rapid change in moisture content and greatly retards the expansion and contraction.

Reinforcement decreases, but does not prevent, the shrinkage and expansion of concrete due to drying and has no effect on temperature changes. Reinforcement cannot, therefore, entirely prevent cracks, but seems to distribute them and keep them small.

Concrete roads are affected by both temperature and moisture. When the drainage is good and the sub-base not wet, the temperature effects seem to be most important. A wet sub-base may add to the temperature expansion by about 0.01 to 0.02 per cent. The restraining effect of friction at the base seems to be almost negligible when figuring temperature and moisture expansion and contraction. In very dry climates shrinkage due to drying must be added to contraction due to fall in temperature. A shrinkage of 0.04 per cent (¼ in. in 50 ft.) is a safe allowance due to drying.

Temperature at time of construction of road should be considered in designing joints. Cold-weather construction requires a full allowance for temperature expansion and, on wet sub-bases, for moisture expansion also. Hot-weather construction theoretically requires no joints at all, even in wet sub-bases, as the temperature contraction exceeds the moisture expansion. However, the difficulty of keeping the cracks clear probably renders joints imperative.

Detouring Traffic Trebles Construction Progress on Road Job

The advantages of detouring traffic around a road construction job instead of letting it through are quite clearly brought out by the following extract from the last annual report of the Massachusetts Highway Commission:

When the Commission let the contract for some resurfacing, it was provided that the contractor should resurface only half the width of the road at a time, keeping flag men at each end and letting the traffic through in single file. Early in the spring when there was but little traffic, this was possible, although it slowed up the work very materially. When the heavy summer traffic began, however, the road became so congested and so many automobiles were always waiting at each end, that there was almost a continuous procession. They kept the sub-base constantly rutted and rough, and almost prevented the teams from getting there that had to haul the material on to the road so that it could be built. It also caused long delays and many complaints, not only from the contractor because he couldn't do his work, but from the motorists themselves.

Consequently, when the Commission found that very little work could be done under these conditions, and that the public would be incommoded for a long time if such a policy were continued, it decided to detour the traffic for a few weeks over a local road which it helped the town to improve and make safer.

As soon as this was done the rate of progress on the road about trebled, the contractor being able some days to secure and place 300 tons of stone a day, whereas while the traffic was using the road it was often impossible to spread as much as 100 tons a day.

Staff Shows that Road Patrolmen Are on Their Sections

Road patrolmen of the State Highway Department of New Hampshire are provided by the department with two cart signs and one staff, all corresponding to the number of the patrolman. The signs are attached with small screws to the seat box of the cart, one sign on each side. The staff is carried in an upright position on the front right-hand corner of the patrolman's cart at all times except as follows: Whenever the patrolman leaves his section so his cart is not noticeable from the road, as in a gravel pit, off the end of his section, or for any other purpose during working hours, he is required to stick his staff in an upright position, with the flag at right angles to the center of the road, where he leaves his section and where he will return to it again. When hauling material the staff is left beside the road when the patrolman is in the bank, but on returning to his section with his load the staff is again placed on the cart and carried until he returns to the pit. On stormy days, when a patrolman is on duty with a carriage or vehicle other than his patrol cart, he will carry the staff in the whip socket to show he is on state work.

Brief History of the American Highway Association, Which Has Just Been Dissolved

The rapid development of an intelligent interest in road improvements in this country has been due to a considerable degree to the work of the American Highway Association, which was dissolved on Oct. 30 by its board of directors, the purposes for which it was founded having been attained. Few of those now interested in the wise administration of public funds for road betterments realize the very unsatisfactory conditions existing when this association was organized and the full measure of the service it has rendered to the country and the several states.

The manner in which the association came into existence affords a good idea of road building conditions in 1900. The director of the United States Office of Public Roads, Logen Waller Page, and B. F. Yoakum, head of the Frisco Railway System, were returning together from a road convention in Oklahoma. It had been characteristic of many of the road meetings of that date—of no real constructive value. There were then a few persons who were making considerable sums by organizing so-called national road congresses and keeping the contributions received from cities where the meetings were held and from commercial interests for the use of space for exhibits. Some of these meetings were conducted properly, but others were notoriously bad. Messrs. Page and Yoakum, who realized that road improvements were in danger of falling into disrepute on account of the exploiting of the public interested in such work by unscrupulous persons, decided that the conditions demanded an active national society with prominent men as its officers, which would of necessity be recognized as the real American highway association and thus be able to assist all those local organizations which were striving to accomplish good work and bring to an end the activities of the undesirable promoters. Accordingly an invitation was issued by Mr. Page to many men interested in road improvements to meet in Washington on Nov. 23, 1910, to organize such a society. At this meeting the American Highway Association was organized "to harmonize and correlate all efforts for the improvement of the public roads, to the end that adequate and efficient systems of road construction, administration and maintenance may be adopted in all of the states."

An early achievement was the organization of good roads trains, which were run through many of the Southern and Middle Western states with the co-operation of seven railway companies and the U. S. Office of Public Roads. These trains were provided with photographs, models and lecturers, and the dates of their arrival at the towns where stops were made were advertised in advance. The technical and economical features of road construction and maintenance were explained and in many cases local good roads associations were formed. The co-operation of railway companies in the work of the association, starting with these early evidences of their interest in road improvements, was a feature of its whole existence. Fairfax Harrison, president of the Southern Ry. Co., was its president for several years prior to its dissolution, and L. E. Johnson, president of the Norfolk & Western Ry. Co., was an active director for some years.

The direct personal work with the people in many states which was carried on with the good roads trains was supplemented a little later by articles prepared for the newspapers. At the time of the dissolution of the association this work had developed so that a weekly bulletin of about 1,700 words relating to various features of road work was being sent to newspapers and agricultural journals with a combined circulation of nearly 9,000,000 copies per issue. This service was given only to papers which requested it. The co-operation of the press with the association in this work was very helpful in bringing to the attention of a large number of persons not easily reached otherwise the value of good roads and the most satisfactory methods of obtaining them.

When the association was organized there was no satisfactory up-to-date compendium of information about the condition of roads throughout the country. The Good Roads Year Book was established to supply such information. The first volume appeared in 1912 and was received at once with marked favor. The 1917 volume was a book of 550 pages. The need of such a large annual volume no longer exists for the U. S. Office of Public Roads has arranged to collect each year statistical information relating to roads, such as formed a considerable part of the Year Book, and a publisher of technical books has undertaken to bring out as an independent book the portion of the Year Book relating to the location, construction and maintenance of rural roads.

An indirect work of the association which proved of decided value was the organization of an annual American Road Congress. Each congress was an independent undertaking, with its own officers and financial management. The purpose was to improve, by example, the character of the national road meetings over those which had been held previously and this object was accomplished successfully. The first of these gatherings was held in Richmond, Va., in 1911, and the others in Atlantic City in 1912, Detroit in 1913 and Atlanta in 1914. In 1915 the association co-operated with the American Road Builders' Association in holding the Pan-American Road Congress in Oakland. The Atlantic City Congress was the first really successful national gathering of road builders and users in the country, and the impetus it gave to such conventions practically made the old irresponsible type of gatherings obsolete. There are other organizations which have lately demonstrated their ability to hold successful road congresses and there is, therefore, no longer any reason for the American Highway Association to continue such work.

From the outset, the association took an active part in assisting legislatures which were considering the enactment of road laws. Every year help of this sort was requested.

With the organization of a highway department in each state, a great enlargement of the activities of the United States Office of Public Roads, and co-operative road building by the nation and the several states, the objects for which the association was founded had been practically attained. The directors therefore decided that rather than undertake new lines of work when the energies of every citizen are directed toward the successful prosecution of the war, the organization should be dissolved. The surplus funds have been invested in Liberty Bonds and the interest will be used in paying for an American Highway Association Prize, to be awarded annually by the Secretary of Agriculture for conspicuous service in the advancement of road improvements in the United States.

Convict Labor on Road Construction in Massachusetts

The use of convict labor in the construction of roads in Massachusetts has proved a success, according to the recently issued annual report of the State Highway Commission, which states that the cost of the work done in this way has been considerably lower than the cost of similar construction elsewhere in the state. The Commission thinks it probable, that with the men costing only $1 per day each, there was a saving of from 20 to 30 per cent and perhaps even more in 1916. The following notes on this work are taken from the above mentioned report:

The Worcester County Commissioners and the Wachusett Mountain Commission some years ago established a camp on Wachusett Reservation, and by an arrangement with the sheriff obtained about 40 convicts, who were used in building the road to the top of Wachusett Mountain and various other roads within the reservation, and in the cultivation of about 15 acres of land.

A small stone-crushing plant was purchased, also a roller, and the various tools that were necessary. The sheriff provided the necessary guards, fed the men, and $1 a day was paid to the county for each laborer. So far as can be ascertained, the county came out about even on the transaction, neither making nor losing much money, because it cost more to feed, guard and transport the men there than it did in the jail.

The road work was under the charge and supervision of the superintendent of the Wachusett Mountain State Reservation. The road to the top of the mountain was widened, the grades very materially improved, and a local-stone macadam road was built. The stone was rolled with a horse roller. It was a most creditable piece of work, and an excellent road was constructed. Quite a few other roads were constructed within the reservation. A camp was constructed for the men at a cost of about $2,500.

In 1915 the Worcester County Commissioners suggested to the town of Princeton and to the State Highway Commission that it would be desirable to improve the highway leading from Princeton village to the foot of the mountain. This road was narrow, had several bad grades, and in many places the natural soil was bad, so that the road was almost impassable in the spring. It was suggested that convicts be used to do this work, and that they could occupy the camp that had been built on the reservation.

The state allotted $2,500, the county of Worcester $1,500 and the town of Princeton $1,000. The road was built 20 ft. wide, with an average width of 14 ft., of local crushed stone 8 in. thick in the center and 6 in. on the sides. On top of this was a covering of hardpan and dust. In building the road a foundation was necessary for part of the distance, and over 1,000 cu. yd. of stone filling was used; there were about 460 cu. yd. of excavation, about 500 yd. of borrow and over 3,200 tons of crushed stone.

The culverts cost about $100; teams cost $4.50 a day; two foremen, $2.50 a day each; and the county received $1 a day for each laborer. There were about 40 convicts at the camp; an average number of 26 were used on the road, 14 being necessary at the camp for farm, camp and commissary purposes. A total of 7,500 ft. of macadam road was built in five months by this gang at a cost of $5,176.

The crushed stone was only rolled with a horse roller. If a steam roller had been used, it would have increased the cost about $250. There was, of course, no charge included for overhead charges, interest on plant, depreciation, etc.

The experiment, however, was certainly a success, because the men were given out-of-door work, which not only improved their health, but undoubtedly was a great benefit to them morally as well.

From the foregoing, states the report, it will be seen that one gang of 30 to 40 convicts, which is about as many as can be used to advantage on a job of this character, can only build about 2½ to 3 miles of road a year, because they can only work five to six months in most places. The amount that can be accomplished with convict labor in road building is limited. They can only be used in a suitable locality where they can be properly housed, guarded, etc., and this must be near the work, or the cost of transportation would be excessive.

This work was continued in 1916. The town of Princeton appropriated $1,500, the county of Worcester $2,000, and the Commission allotted $3,500.

The work was done under the supervision of the superintendent of the Mt. Wachusett Reservation, who served without pay. There were two foremen on the work, one at the crusher and getting out field stone, and the other looking after the grading and the placing of the stone. The foremen were paid at the rate of $2.50 a day, and $4.50 a day was paid for the necessary double teams.

The length constructed was 5,800 ft., 15 ft. in width of local crushed stone, with suitable shoulders on each side. The area was 9,667 sq. yd. computed on the hardened surface alone, and the approximate cost of the road surface, including excavation, foundation, gutters, shoulders and drainage, was 67 ct. per square yard.

The following shows the estimated quantities and approximate unit cost of each item of work done:

Excavation, 1,700 cu. yd., at 31 ct.	$ 527.00
Borrow, 650 cu. yd., at 42 ct.	273.00
Stone fill, 3,035 cu. yd., at 86 ct.	2,610.10
Broken stone, 2,900 tons, at 96 ct.	2,784.00
Repairing culverts	249.99
	$6,444.09

In 1916 much more excavation was necessary than on the 1915 section, and much more of the road required a stone foundation; therefore the length constructed was less. In 1915 there was about 460 cu. yd. of excavation, while in 1916 there was 1,700 cu. yd. The stone filling necessary in 1916 was 3,035 cu. yd., as compared with 1,000 cu. yd. in 1915.

The work was planned by the engineers of the Commission, and was under the general direction of one of its assistant division engineers. He states that the work has been handled in a very economical manner and full value has been obtained with the amount expended. This most interesting work has been carried on under the most favorable conditions, a camp having been already provided within the reservation and very near to the work.

General Conference of Paving Brick Industry.—A general conference of the paving brick industry has been called by the National Paving Brick Manufacturers' Association. The conference will be held in connection with the annual meeting of the association in Cleveland, O., on Nov. 19 and 20, and all manufacturers of paving brick are invited to attend. The conference will consider the problems arising from war conditions.

Methods of Renewing Surface of Old Macadam Roads

Most of the suburban roads in the District of Columbia are water-bound macadam which have had a surface treatment either of oil or light tar. Three methods of renewing the surface on these old and worn macadam roads are employed, depending upon the condition of the road to be repaired.

When the surface has been treated formerly with oil or tar and is in generally good repair, except for a few potholes or ruts, these places are patched with a mixture of stone, of a size corresponding to the depth of the depression, and a cold bituminous material. This material may be either a tar of the heaviest consistency which can be used cold, such as Tarvia K-P or Ugite C; or it may be an asphaltic emulsion such as Headley's Cold Patching Material No. 1. The largest size of stone possible is used, well mixed with about 1 gal. of bituminous material to each cubic foot of stone. The patches are rolled with a steam roller and covered with a thin coat of stone chips to prevent adhesion to wheels while they are still moist.

When the surface of a macadam road, which has been previously treated with oil or tar, is very much worn or rutted, the entire surface is loosened to the depth of about 2 in. with a scarifier, as much as possible of the top coat containing the bituminous material being entirely removed. The fine stone may be screened out of the material which is removed if it is sufficiently pulverized, but it is usually reserved for use in repairs to little traveled roads. Sufficient new stone is then added to restore the proper cross section of the road, and the surface is brought to the condition of new water-bound macadam. This is opened to travel and kept watered until the surface is firm and compact. It is then swept clean of dust and the new surface is treated with the bituminous material in the same manner as a new road. About ¼ gal. per square yard of bituminous material (either oil or tar) is spread by means of a sprayer, and the surface is then covered with stone chips or pea gravel.

When the surface is much worn and it is desired to renew it with a strong new surface, the old macadam road is scarified to a depth of about 3 in. and reshaped to a surface about 2 in. below and parallel to the finished surface. A layer of 2-in. stone is then added and rolled to restore the cross section. About 1½ gal. per square yard of hot tar of heavy consistency is then applied, covered with stone ¾ in. to 1 in. in size, and rolled. After this a second coat of tar of about ⅔ gal. per square yard is applied and covered with ½-in. stone chips and rolled. This is, of course, the well-known penetration method, applied to the re-surfacing of old roads, and its use is advisable in cases where the road sustains a fairly heavy traffic of both horse-drawn and motor vehicles of all classes, say from 500 to 1,500 vehicles in 24 hours for a roadway 20 ft. wide.

The cost of the above treatments depends largely upon the condition of the roads when repaired, and also upon the cost of labor and material at the particular location under consideration. In a general way, in the District of Columbia, the mixed bituminous material used in the first method costs from $1.40 to $1.50 per cubic foot in place in the road. If it will average 1 in. deep, then it will cost 12 to 12½ ct. per square foot or $1.08 to $1.12½ per square yard of patch (not of roadway surface). This applies to small patches. Larger patches would cost somewhat less per square yard. To patch a roadway, 2 per cent of whose surface required repair to an average depth of 1 in., will therefore cost about 2 ct. to 2½ ct. per square yard of roadway surface.

The second method will cost probably 10 ct. per square yard for the preliminary work and from 5 to 6 ct. per square yard for the new surface treatment, or a total of 15 to 16 ct. per square yard of roadway surface.

The third method, including the work of scarifying and reshaping and the cost of material and labor, will cost from 60 to 75 ct. per square yard, depending on many and various factors.

The costs are based on labor at about 30 ct. per hour, teams at $5.50 per day, stone at 10 ct. per cubic foot at the road, and bituminous materials at 10 ct. to 15 ct. per gallon at the work. L. R. Grabill is Superintendent of the Suburban Roads of the District of Columbia.

Costs of State Roads in California

Some figures on the cost of highways constructed under the direction of the State Highway Commission of California were given by Mr. Walter C. Howe, Division Engineer of the Commission, in a paper presented Aug. 21 before the San Francisco Association of Members of the American Society of Civil Engineers.

On account of the widely divergent conditions, in different parts of the State, pavement costs have materially varied. As an example: The cost of an asphalt, a concrete or an oil macadam pavement in the vicinity of Oakland, should be considerably less than the same class of road near San Luis Obispo. The reason for this increased cost is apparent when it is explained that asphalt plants in the latter locality must be specially erected for the job or railroad plants brought in at considerable expense. Rock is often hauled 160 miles on account of lack of first-class gravel deposits or successful operating rock quarries. Long wagon hauls from the railroad are the rule rather than the exception, and oil, cement, steel, and even sand are hauled, subject to the same expensive freight hauls. On this account the fairest comparison in costs must be made in sections where conditions of supply, haul, grading quantities, etc., are similar.

In the several counties where these conditions are found, the cost of an oil macadam road, 15 ft. in width, averaged $6,950 per mile, while oiled concrete averaged $7,400 per mile.

On the San Francisco Peninsula, where the concrete base is heavier and the roadway 24 ft. wide, the average cost of an asphalt pavement was approximately $19,000 per mile, while asphalt on a macadam base ranged from $6,800 per mile on an old scarified macadam, to $15,500 per mile on a new 5-in. base, the roadway being 20 ft. in width. These latter costs apply to a wearing surface of either Standard asphalt or Topeka surface, both 1½ in. thick.

Method of Handling Street Openings at Toledo, O.—A new policy adopted by the Service Department of Toledo, O., provides that no permits for street openings will be issued for 3 years following the completion of a pavement. A placard, reading as follows, is tacked up at streets which are to be improved:

Notice!

Legislation has been passed for the improvement of this street by paving. Work will start on ...., 19..... Water, Sewer and Gas connections must be made at once, as no street opening permits will be issued for 3 years.

Road Construction in United States in 1916

Cash expenditures on the rural roads and bridges in the United States in 1916 amounted to $272,634,424, according to a circular prepared by the Division of Economics of the U. S. Office of Public Roads and Rural Engineering, and issued last month by the U. S. Department of Agriculture. To the above figures should be added the value of the statute and convict labor, which probably amounted to at least $15,000,000, thus making the grand total expenditure for the year $288,000,000.

According to the circular the public rural roads of the United States at present have a total length of 2,455,761 miles, of which about 287,000 miles, or 11.6 per cent, are improved with some form of surfacing. The mileage of hard surfaced roads is increasing at the rate of about 15,000 miles per annum. During 1916 the States having State highway departments surfaced about 7,000 miles under State supervision and also improved an additional 9,000 miles by grading or otherwise. In addition to this construction work the several State highway departments also supervised the maintenance of 75,811 miles of main and trunk line highways.

From 1904 to 1915, inclusive, the annual increase in the expenditures on rural roads and bridges amounted to approximately 12 per cent over each preceding year. The increase of 1916 over that of 1915, however, was only 2 per cent. This was due largely to the scarcity of labor and materials which caused an unusually large number of contracts to be carried over to this year. In New York State alone, contracts involving about 900 miles cf state and county highways were left uncompleted at the close of 1916.

Of the total cash expenditures of $272,634,234 for 1916, $198,138,859 was local road and bridge expenditures not under the State highway department. The remaining $74,495,554 was expended by or under the supervision of State highway departments. Of this later total, $40,969,000 were State funds and $33,526,553 were local funds. The distribution of expenditures by or under the supervision of State highway departments was as follows:

Construction of roads	$44,469,824
Construction of bridges	5,414,331*
Maintenance of roads and bridges	18,452,861
Engineering	3,656,705*
Administration	1,572,292*
Equipment and miscellaneous	929,554

*Partial totals.

Table I shows the mileage in the several States of State and State aid roads built to Jan. 1, 1917. It also shows the total of the state funds expended since the passage of the State law.

The figures for the cash road and bridge expenditures in all the States for the calendar years 1904, 1914 and 1916 are summarized below:

	1904.	1914.	1916.
State funds expended by or under State Highway Department	$ 2,549,850	$ 24,220,850	$ 40,969,001
Total cash expenditures from all sources	59,427,180	240,263,784	272,634,424

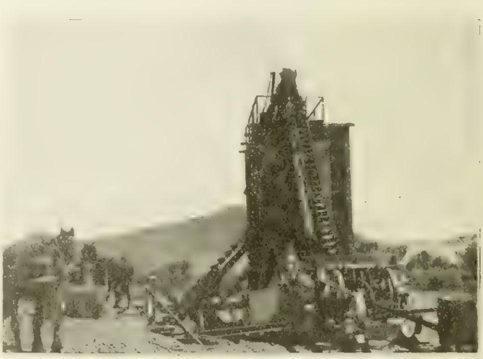
TABLE I—TOTAL MILEAGE OF STATE AND STATE AID ROADS AND TOTAL STATE EXPENDITURES.

	Total all state and state-aid roads built to Jan. 1, 1917. Miles.	Total all surfaced roads in state (approximate). Miles.	Total all public rural roads in state. Miles.	Total state funds expended for rural work from passage of state law to Jan. 1, 1917.
Alabama	659	6,000	55,446	$ 688,827
Arizona	372	375	12,075	1,480,590
Arkansas	534	1,500	50,743	220,483
California	1,907	12,300	61,039	20,857,055
Colorado	[1]7,305	1,800	39,780	1,632,379
Connecticut	[2]1,627	3,100	14,061	18,395,527
Delaware	160	275	3,674	255,695
Florida	...	3,500	17,995	11,619
Georgia	...	13,000	80,669	....
Idaho	413	800	24,396	672,869
Illinois	767	12,400	95,647	2,505,829
Indiana	...	31,000	73,347	......
Iowa	...	1,000	104,074	346,756
Kansas	...	1,400	111,052	40.000
Kentucky	1,611	13,400	57,916	1,325,061
Louisiana	752	2,400	24,563	790,860
Maine	1,798	3,250	23,537	6,920,459
Maryland	1,321	2,900	16,459	19,863,142
Massachusetts	1,998	8,900	18,681	21,701,228
Michigan	3,940	9,600	74,190	4,165,640
Minnesota	10,011	6,500	93,517	5,678,699
Mississippi	...	2,600	45,779	6,500
Missouri	[3]...	7,250	96,041	2,214,032
Montana	30	800	39,204	60,496
Nebraska	...	1,350	80,272	487,850
Nevada	...	320	12,182	20,000
New Hampshire	1,280	1,900	14,020	3,674,458
New Jersey	2,054	6,000	14,817	9,523,419
New Mexico	846	550	11,873	1,048,639
New York	6,765	18,000	79,398	106,032,153
North Carolina	...	6,750	50,758	48,500
North Dakota	...	1,100	68,796	....
Ohio	1,299	31,500	86,354	14,558,300
Oklahoma	1,900	300	107,916	330,323
Oregon	413	4,875	36,819	584,697
Pennsylvania	1,988	10,500	91,556	34,464,563
Rhode Island	325	750	2,170	4,450,936
South Carolina	..	3,700	42,226	....
South Dakota		750	96,306	....
Tennessee	150	8,750	46,050	203,500
Texas	.	12,000	128,960	....
Utah	3,440	1,500	8,810	989,132
Vermont	2,011	2,100	14,249	4,304,364
Virginia	4,463	5,500	53,388	8,412,461
Washington	1,977	5,900	42,428	141,945
West Virginia	...	1,532	32,024	5,169,001
Wisconsin	5,070	14,850	75,707	43,237
Wyoming	...	520	14,797	....
Total and av.	69,186	287,047	2,455,761	$307,937,838

[1] Includes about 6,300 miles of earth roads. [2] Includes 195 miles of reconstruction. [3] No data.

Portable Crushing Outfit for County Road Work

By means of a portable crushing outfit the Commissioners of Malheur County, Oregon, have been able to crush, deliver and spread rock on their roads at a cost of 66⅔ ct. per cubic yard. The average haul was approximately 2 miles. This plant, shown in the accompanying illustration, consists of a No. 2 steel frame Aurora jaw crusher mounted on wheels, a 36-ft. elevator, a 32-in. x 8 ft. revolving screen, and 75-cu. yd. bunkers with three compartments of equal size and side discharge. The crusher is fed with a 16-ft. elevator mounted on trucks, driven by a gas engine. The material is conveyed to a trap over the loading elevator with Western No. 1 slip scrapers. The product is hauled to the roads with 3½-yd. Troy reversible spreading wagons drawn by a gas traction engine. The capacity of the outfit averages about 250 cu. yd. for a 10-hour run on river bed gravel, composed of material ranging from pea size to 8-in. boulders.



Crushing Plant of Malheur County, Oregon.

Method of Using Calcium Chloride in Gravel Road Maintenance

Calcium chloride is used in certain road districts of Connecticut in connection with the maintenance of gravel roads. The method employed is described as follows by Mr. A. C. Innis, Supervisor of Repairs of State Highway Department:

The calcium is spread on the gravel road with a machine such as is used for spreading lime on farm land. The cans are opened and the contents placed in the hopper of the spreader and the machine set to use about 2 lb. to the square yard. It is spread evenly and in as near this amount as possible. This is done as soon as the ground has settled in the spring. Then, if necessary, and it will be necessary, especially where this calcium chloride is being used for the first time, another coat is put on later in the summer, usually about the middle of July. Of course, the roads are kept constantly dragged and smoothed up so that no pit holes are allowed to form in the road.

If under very wet weather conditions, the road becomes pitted, as soon as it is suitable to go on, a load of gravel and a can of calcium is put onto a truck with two or three men as it is thought best, and the road is gone over thoroughly. Every uneven place is filled with gravel and a little calcium is sprinkled onto this. It may be necessary to do this several times during the season, depending upon the amount of travel that the roads receive. Patching as described above and dragging should be the motto on all roads which are to be maintained by the use of calcium chloride. If prior to the first application the road is dusty to any considerable extent, it should be swept off and thoroughly wet down with a sprinkling cart before the application of chloride is made.

Two of the roads on which the calcium chloride is used have an average traffic of about 1,200 to 1,500 vehicles per week. During one week in October, when there is a State fair in a nearby town, the roads carry as high as 25,000 vehicles per week. They also are subjected to considerable motor truck traffic. The roads are maintained by the patrol system.

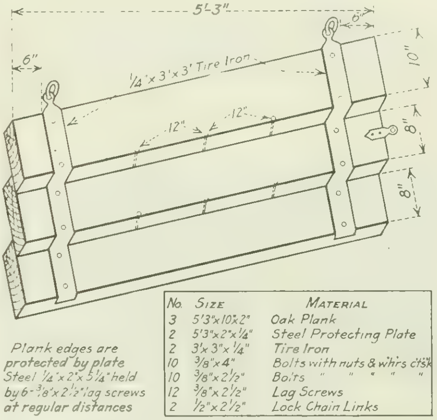
Factors Governing Selection of a Pavement

In order to give property owners a definite idea of the various factors that should be taken into consideration in the selection of pavement, a table of standards has been prepared by Mr. H. C. McClure, Commissioner of Engineering and Construction of the city of Toledo, O. The table, which is reprinted below, suggests the qualities that should govern the choice of a pavement and their relative order of importance for various classes of districts:

Order of Importance.	Office Building and Retail Stores District.	Wholesale Warehouse and Dock or Railroad District.	Boulevards and Expensive Residential District.	Medium and Cheaper Residential Districts.	Through Traffic Thorofares All Districts
1.	Noiselessness.	Durability.	Appearance.	Appearance.	Durability.
2.	Appearance.	Tractive Resistance.	Durability.	Cost.	Tractive Resistance.
3.	Sanitariness.	Ease of Maintenance.	Sanitariness.	Durability.	Slipperiness.
4.	Durability.	Slipperiness.	Ease of Cleaning.	Sanitariness.	Appearance.
5.	Ease of Maintenance.	Sanitariness.	Noiselessness.	Ease of Maintenance.	Ease of Maintenance.
6.	Ease of Cleaning.	Appearance.	Slipperiness.	Ease of Cleaning.	Noiselessness.
7.	Slipperiness.	Ease of Cleaning.	Tractive Resistance.	Noiselessness.	Cost.
8.	Tractive Resistance.	Noiselessness.	Cost.	Slipperiness.	Sanitariness.
9.	Cost.	Cost.	Ease of Maintenance.	Tractive Resistance.	Ease of Cleaning.

Road "Smoothing Board"

The smoothing board shown in the accompanying sketch is employed in gravel road maintenance work in one of the districts of Connecticut of which Mr. A. C. Innis is Supervisor. This "drag" is used early in the spring or during freezing or thawing times of the winter to level the roads. The action of drawing the boards over the surface smooths down the small ruts, and carries forward just enough material to fill up the little depressions. It is wholly a rubbing down tool rather than a dragging in device.



Plank edges are protected by plate Steel 1/4"x 2"x 5 1/4" held by 6-3/8"x 2 1/2" lag screws at regular distances

No.	Size	Material
3	5'3"x10"x2"	Oak Plank
2	5'3"x2"x1/4"	Steel Protecting Plate
2	3'x 3"x 1/4"	Tire Iron
10	3/8"x4"	Bolts with nuts & whrs ctsk
10	3/8"x2 1/2"	Bolts " " " " "
12	3/8"x2 1/2"	Lag Screws
2	1/2"x2 1/2"	Lock Chain Links

Details of Road "Smoothing Board."

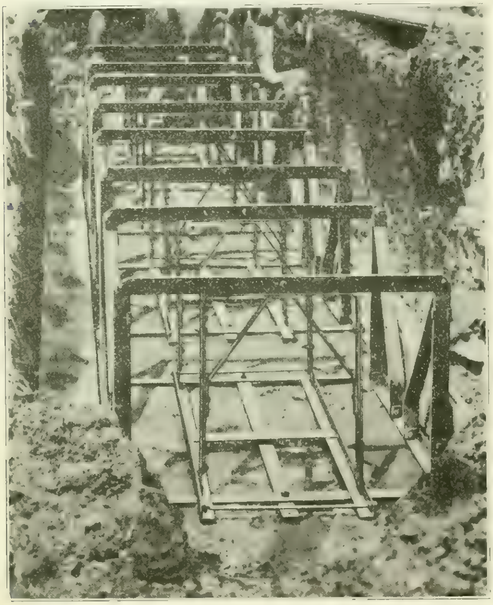
City Maintains Roads by Patrol System

The city of Laconia, N. H., of which Mr. Chas. A. French is City Engineer, has applied the patrol system for maintaining some of its thoroughfare. This method is not employed on the paved streets, but is used on the outlying roads within the city limits. A patrolman, equipped with a horse, cart, drag and tools, is placed in charge of about 6 miles of road. He is paid 44 4/7 ct. per hour. He drags the roads when they are in proper condition for this work, cleans out the waterways and patrols the roads when not dragging. The results are stated to be excellent and economical.

Two-Course Concrete Roads in Wayne County, Michigan.—With the exception of emergency roadways all the concrete roads built during the past year by the County Road Commissioners of Wayne County, Michigan, have been of the 2-course type, using Wisconsin granite or trap rock for the wearing course and washed pebbles or crushed limestone for the lower course.

A One-Man Collapsible Culvert Form

A new collapsible culvert form of particular interest to road builders has recently been placed on the market by the Storms Manufacturing Co., 53 W. Jackson Blvd., Chicago, Ill. The form is made of iron bars and comes in separate sections each 4 ft. long. It is so constructed that it can be extended horizontally and vertically, thus permitting a wide range of adjustment. The forms are furnished in two sizes: The No. 1 size can be used for culverts from 14 by 16 in. to 22 by 28 in. inside dimensions, and length from 4 ft. to 30 ft.; the No. 2 size can be used for culverts with inside dimensions from 24 by 26 in. to 36 by 46 in. and lengths from 4 ft. to 30 ft. These figures are based on the use of 2-in. lumber for casing. The forms are tripped by pulling on the cross rod, which causes the frame to collapse and gives the necessary clearance for the removal of the casing lumber. After the lumber has been withdrawn, a pull at the center bar of the form draws in the side sills, giving ample clearance for pulling out the forms. It is claimed that the forms have sufficient strength and rigidity to sustain the weight of fully 2 ft. of concrete without sagging. The collapsing and removal of the forms including the lumber, in several recent jobs, has been accomplished by one man in less than 5 minutes' time.



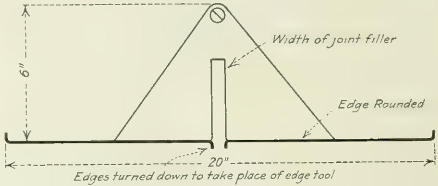
Form in Position Ready for Lumber Casing.

In 1909 there were 722 miles of toll roads in Pennsylvania. In the last 6 years nearly 200 miles of these roads have been made free by the state and local authorities and over 40 miles more will be freed in a few weeks.

Road Improvement District No. 1 in St. Francis County, Arkansas, is calling for bids for constructing 42 miles of gravel, concrete and asphaltic macadam road. The work includes 290,000 cu. yds. of earthwork, 40,000 cu. yds. of concrete and 98,000 cu. yd. of gravel.

Split Float for Concrete Road Work

The split float, illustrated below, has been used with success on the concrete road construction in Stanislaus County, California. The device is made from one piece of 1/16-in. sheet steel. It is used to smooth down the slight unevenness on each side of an unprotected joint filler, and it also serves the purpose of an edge tool. The float was designed by E. H. Annear, Chief Engineer of the Stanislaus County Highway Commission.



Split Float Used on Stanislaus County, California, Road Work.

Personals

A. F. Stotler, heretofore supervisor of bridges and buildings, Northern Pacific Railway, has been appointed division engineer, with headquarters at Tacoma, Wash.

N. S. Mullican has been appointed chief engineer of Davidson County, North Carolina. Mr. Mullican has resigned as city manager of Thomasville, N. C., in order to accept the new position.

U. S. Marshall, formerly assistant engineer of the County Highway Commission of Sacramento County, California, is now road engineer at the government cantonment at Camp Lewis, Washington.

Santa Barbara, Cal., a city of over 20,000 population, has invited applications for the position of city manager under the new charter which becomes effective Jan. 1, 1918. Applications must be filed with the City Manager Committee, P. O. Box 6, Santa Barbara, before Dec. 1, 1917.

The following named officers of the Engineer Officers' Reserve Corps have been assigned to the 306th Engineers, Camp Jackson, Columbia, S. C.: First Lieuts. Francis H. Kingsbury, Percy Chambers, Ambrose Harwell, Albert T. De Baun, Jr., Elmer G. Fuller and Donald W. Green; Second Lieuts. Ruel E. Nottingham, George S. Bradford, Harry J. Pfaff, Jr., and Frank S. Neely.

Clifford Older has been appointed by Governor Lowden as chief highway engineer of the Department of Public Works and Buildings of the State of Illinois to succeed William W. Marr, who died several weeks ago at his home in Chicago. Mr. Older is a bridge engineer of the Department of Public Works and Buildings and has been acting chief engineer since the death of Mr. Marr.

Maj.-Gen. John Biddle has been appointed assistant chief of staff of the U. S. War Department to fill the vacancy caused by the appointment of Gen. Tasker H. Bliss as chief of staff. Maj.-Gen. Biddle is a native of Michigan and was born Feb. 2, 1859. He was appointed from that state to the Military Academy Sept. 1, 1877, and graduated with the class of '81. He returned to the academy as superintendent in 1916 and served approximately a year in that capacity. He was appointed a brigadier-general and assigned to the line a few months ago. During the Spanish-American war Gen. Biddle served as lieutenant-colonel, chief of engineers. After the war he returned to his rank of captain in the engineer corps. He was promoted to be a major in 1901, was made lieutenant-colonel in 1907 and colonel in 1911. From April 14, 1911, to June 15, 1914, Col. Biddle served as a member of the general staff. For a comparatively short time he was assigned to duty as engineer commissioner of the District of Columbia.

Industrial Notes

H. M. Lee, president of the Duplex Truck Co., of Lansing, Mich., annnounces that Herman Loeffler has become a member of the Duplex sales department and will represent the company in the eastern states. Mr. Loeffler was connected with the Fairbanks-Morse Co. for 10 years, and for the last 3 years has been associated with the Novo Engine Co. of Lansing.

C. E. Hoyt and E. C. Hall have become associated with the National Exhibition Co., 123 West Madison street, Chicago, which will hold the cement machinery and building equipment show in Chicago on Feb. 6 to 13. Mr. Hoyt has been secretary and manager of the annual foundry and machine tool shows for a number of years. Mr. Hall has had years of experience with safety, foundry, educational and other trade conventions.

Setting as their goal subscriptions amounting to $1,500.000 worth of Liberty Bonds, the employes of the Westinghouse Electric & Mfg. Co. at the close of the campaign had secured subscriptions amounting to $1.610,000, or an over-subscription of $110,000 beyond their goal. The employes of the subsidiary companies subscribed approximately $620,000 and the company itself has subscribed for $2,500,000, making a grand total for the company of approximately $4,730,000. An interesting fact in connection with this bond subscription is that out of approximately 30,000 employes 22,000 subscribed to the bonds.

Water Works and Hydraulic
Monthly Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Screets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellaneous

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

Volume XLVIII. CHICAGO, ILL., NOVEMBER 14, 1917. Number 20.

ATTENTION!

Turn back three pages to advertising page 16. The publishers of Engineering and Contracting have there printed a message that should interest you.

The Effect of Installing District Meters in Different Parts of a Water Works System

Eventually every city water works will be districted and the water that flows into each district will be metered by what may be called a "district meter." In the Metropolitan Water District of Boston and neighboring cities there are 69 Venturi meters that measure the water flowing into each of 69 districts. As a result of the installation of these meters and the individual metering of about 67 per cent of the services, the per capita consumption of water has fallen from 130 gal. in 1907 to 89 gal. in 1916, or a reduction of more than 30 per cent in water consumption.

Between the hours of 1 and 4 a. m. an amount of water equivalent to 6.5 gal. per capita passes through the 69 Venturi district meters, showing conclusively that a large water wastage occurs even during the time of night when little water is used effectively. District meters disclose such facts as this, which individual meters do not disclose; and, what is more important, district meters show exactly what districts are wasting the most water. In one of the residential districts of Boston, for example, the water consumption has been reduced to 45 gal. per capita, effecting a water saving of more than 60 per cent.

District meters are relatively inexpensive. The 69 Venturi meters above mentioned cost only 80 ct. per capita of population served, or about $600 per square mile of city. This cost is so slight and the economic gain so great that we are safe in predicting the almost universal use of district meters in the near future, provided hydraulic engineers and water works managers will study the problem and present to the public convincing data as to the annual per cent of profit resulting from the use of such meters. In another editorial we have briefly discussed the matter of financing public improvements of this kind.

Would the Union of Two Water Works Associations Be an "Entangling Alliance?"

In his presidential address to the New England Water Works Association, Caleb Mills Saville said:

> The past experience of this association, with its avoidance of entangling alliances, is the best guide we can have for the future. Our present position as a power in water department matters shows clearly the wisdom of the founders of this association in rigidly excluding both politics and commercial exploitation from its voting membership. "As with the Fathers so may God be with us." With other organizations we will work together gladly and we welcome all waterworks men to our membership. Careful consideration of our own particular needs and purposes, however, forbids any thought of combination with others.

The evident implication of these words is that a union with the American Water Works Association would weaken the influence of the members of the New England Water Works Association, mainly because of "politics and commercial exploitation." But, granting for the sake of argument that "politics" has been more in evidence in the American Association than in the New England Association, does it follow that "politics" would be powerful enough to control the joint membership of both associations? It must be conceded that society politics becomes less effective as societies grow larger; and it must also be granted that, to say the least, a very large proportion of the members of the American Association can not be influenced by "politics and commercial exploitation." Then if to these non-partisan members be added the members of the New England Association, what would become of the remaining small minority of wire-pullers?

We think that Mr. Saville and the other officers of the New England Water Works Association who have opposed the union of the two societies, have failed to consider the full force of the objections to their objections. Indeed, does not their appeal to the "wisdom of the fathers" itself betoken the weakness of their argument?

The Apathy of Municipal Engineers and Waterworks Superintendents of California

Ninety-one of the 241 cities of California were represented by delegates of the twentieth annual convention of the League of California Municipalities (Sept. 24-29) at which 360 delegates registered. The names of only 25 engineers and 2 waterworks superintendents are to be found in the list of 360. Yet the objects of this league, which we give below, surely would lead us to expect that nearly every one of the 91 cities would be represented by at least one civil engineer and one waterworks superintendent:

The dues of the league are not an obstacle, for they are paid by the municipalities. It would seem, therefore, that the traveling expense is the main deterrent to attendance at the annual conventions. But we note that 30 city attorneys were among the delegates, indicating either that their cities paid their traveling expenses or that city attorneys are more public-spirited than city engineers.

In any event there is evidenced here a regrettable lack of determination on the part of city engineers and waterworks superintendents to play a leading part in civic affairs. If they would go before their city councils and present reasons why their expenses to the convention should be paid, we doubt not that most of them would be authorized to make the trip at the expense of the public. Surely the public would be the gainer by having its trained employes attend the conventions of an organization whose objects are:

(1) To provide means whereby officials and others interested in municipal government may interchange ideas and experiences;

(2) To maintain an official headquarters and information bureau for the collection and dissemination of knowledge relating to municipal affairs;

(3) To secure the enactment of beneficent legislation for municipalities, and prevent the passage of such measures as may be inimical to their interests;

(4) To prosecute or defend any interest common to its members;

(5) To promote education in municipal government; and

(6) To do any and all other things necessary or proper for the benefit of municipalities.

Each member of the legislative body, and each city clerk, attorney and engineer of the municipalities belonging to the league shall be placed on the mailing list of the official organ and receive a free copy thereof each month. Upon special request any other officials of such municipalities shall be added to the mailing list without charge.

The Welding of Pipe Joints by Oxy-Acetylene

During recent years many gas companies have laid a great deal of pipe whose ends have been welded instead of screwed together. Not only has the first cost of the pipe lines been materially reduced, but gas leakage has been practically eliminated by the use of welded joints.

Wherever steel or wrought pipe is used—whether for gas, steam or water—the welding of the joints certainly merits consideration. An oxy-acetylene welding apparatus is very inexpensive and men are readily trained to use it. The acetylene can be bought in small tanks that are readily portable. The same apparatus can be used to cut pipe, to make "specials," etc., furnishing, in short, a useful all around tool.

In our next Waterworks and Hydraulic Monthly issue, Dec. 12, there will be given several illustrations of the application of oxy-acetylene in pipe welding and cutting. The National Tube Co., of Pittsburgh, has issued Bulletin No. 26, containing some 50 pages of useful data and information relative to "autogenous welding" of pipe. The Prest-O-Lite Co., of Indianapolis, Ind., has published a useful 24-page pamphlet on welding and cutting by the aid of oxy-acetylene.

Recruits Wanted for Water Supply Service in France

A regiment for water supply service in France is now being recruited. There will be 6 companies of 250 men each that will constitute the "26th Engineers." About two-thirds of these must be skilled artisans.

The following types of skilled men are particularly lacking: Draftsmen and letterers, photographers and blueprinters, blasters and powder men, skilled mechanics for auto repairs, steam and gas-engine runners, pipe calkers and lead-furnace men, masons and concrete workers, experienced well drillers, machinists, pipe fitters, mappers and surveyors, electricians, riggers and laboratory assistants.

Among our readers there are doubtless a good many civil engineers, contractors and superintendents who will apply for enlistment as officers. Others will be able to induce skilled artisans to enlist. Communications should be sent to Col. E. J. Dent, Camp Dix, N. J.

How to Facilitate the Financing of Public Works

Remove the element of direct and easily ascertainable profit on an investment and there inevitably follows doubt as to the wisdom of the investment. Curtailment of further investment follows doubt, and retarded economic progress is, of course, the consequence of unwise curtailment.

It is notoriously difficult to secure appropriations of public monies for public works of economic merit, largely because there is no ready means of measuring the degree of merit, such as a private corporation can exhibit. The per cent of net earnings on the investment in a private toll road, for example, forms a definite measure of the economic wisdom of the investment; but a good public road showing no direct earnings at all may appear to be a luxury, although in reality it is highly profitable to the public that it serves.

Where individual charges are not made for the use of public roads and streets, and the like, it would seem to be desirable to have annual estimates made by engineers to show, in dollars, the annual worth of such works to the public. Certainly when new public plants or extensions to old ones are planned, an effort should be made to show what annual "profit" upon the investment is to be expected. The "profit" in such a case would be the annual saving of time, health, etc., all expressed in dollars. Thus in the case of a proposed investment in a water treatment plant, the annual value of lives and health conserved should be estimated, and shown as a percentage on the investment inclusive of the capitalized operating expense; or the annual value of lives and health conserved, less the annual operating expense, which would constitute the annual net profit, should be shown as a percentage on the investment in the plant.

Certain manufacturers of liquid chlorine apparatus have gathered and published statistics showing the annual health value arising from the use of liquid chlorine. Engineers and water works superintendents can advantageously use such statistics in reporting upon the economic advisability of chlorinating city water.

Similarly, if the annual worth of all public works were expressed in dollars, it would become much easier to secure appropriations for neded public improvements.

Road Building Regiment Needs More Skilled Artisans

Col. E. N. Johnston, commander of the "23rd Engineers," informs us that more than 1,000 recruits are now in uniform at Camp Meade, Admiral, Md. Applications have been received at the rate of 500 a day, so that probably more than 10,000 applications will have been received up to this date. Although only 10,500 men are needed, it happens that those fitted for the higher positions are coming forward in large numbers, whereas there is a relative scarcity of skilled artisans, such as roller men, rock crusher and enginemen, bridge carpenters, etc. Accordingly our readers will perform a patriotic service by calling the attention of such men to the opportunity to enlist in this road building regiment. Communications should be addressed to Col. E. N. Johnston, 1419 F St., Washington, D. C.

Proper Municipal Accounting and Its Importance to Our Readers

How many of our readers who are employed by municipalities have ever given thought to the effect that adequate municipal accounting might have upon their personal welfare? If you were working for a company whose ledgers were notoriously ill kept and whose management was characterized by lack of system, would you be surprised if your salary were small and your advancement slow? Would you not regard your ill fortune as a direct consequence of the absence of proper accounting and system? And would you not eventually decide to leave such a company to the financial doom that it justly merited? Can you not see that what holds true of a private corporation is equally applicable to a public corporation—a city?

Taxpayers in American cities have come to regard inevitable the waste of much of the money that is collected from them for public use. Those of them who are business men know well what the waste and inefficiency would be were their own private accounting as poor as that of the average city. So they resolve to keep down their taxes, even at the expense of poor pavements, poor schools and inadequate salaries to city engineers, teachers, etc.

In a paper on "Municipal Accounting" read before the recent convention of the League of California Municipalities, Mr. David C. Scribner said:

> To sum up the present status of city bookkeeping, it is safe to say that for the most part it is yet primitive in form; that the published reports we receive, even when modeled on uniform lines are little more than an analysis of the treasurer's transactions; and that generally there is no correct accounting for revenues and expenses for corresponding periods.

He points out the desirability of a uniform system of accounting for all cities in a State, and correct annual financial reports to the State controller, whereby costs in one city may be compared with those in other cities of like size. And he gives other excellent advice, none the less excellent and needed, though not entirely new.

Our cities are woefully slow in acting upon such recommendations. Let our readers join with other earnest men in the effort to make cities adopt satisfactory accounting and cost keeping systems.

Occasional Extravagance or Even Fraud is Often Less Costly than "Red Tape"

Laws and rules for the conduct of public business are designed to make fraud difficult and dangerous. Government "red tape"—against which violent imprecations are so common—is largely a device to insure honesty. But "red tape" is admitted by all to be expensive, so expensive at times that it defeats its main function of conserving public funds.

Who that has worked for a government does not recall many an instance of waste of valuable time consequent upon delays in securing materials or supplies through formal requisitions? Even a much needed pencil or bottle of ink is often unavailable for days because it must be secured from a central distributing bureau upon written order signed and countersigned, "okayed" and bouquetted, sealed and initiated, until the order looks like a foreign suitcase plastered with the names of most of the hostelries of Europe. And all for what end? To preserve a uniform system? No. To keep down cost? Yes. But there are times when "system" and "red tape" cost more than they save. If a system of requisitions, for example, is very elaborate and detailed, it may well be that an occasional theft or extravagance will be prevented, but the resulting saving may be far less than the expense of maintaining the elaborate system. Better, then, the theft than the system.

Who has ever investigated this matter thoroughly? Where should the line be drawn between wide "red tape" and a very thin little red thread? Now that the federal government is engaged so stupendously in enterprises of every character, including the rolling and unrolling of countless reels of "red tape," it would seem that it might be profitable to determine the economic limitations of "system."

Stone, Gravel and Sand Shipments Curtailed by Shortage of Gondolas

For some time the shortage of gondola cars has been acute. Now the Priority Board of the Council of National Defense has issued an order that gondolas must not be furnished for road and street work until such time as coal shipments are better cared for. Flat cars, however, may be used for carrying highway materials, and already many contractors and shippers are building sides on flat cars for use in hauling road materials.

The fear of a coal famine accounts largely for the present shortage of gondola cars; but since the government is taking steps to allay the fear and to stop the hoarding of coal, it is probable that we shall not long have to endure restriction in the use of gondolas.

The Treatment of Packing-house Wastes by Activated Sludge Process

Large-scale experiments to determine the possibilities of the activated sludge process for the treatment of packing-house wastes were begun early in 1916 by the Sanitary District of Chicago. These experiments have been continued and have been successful in demonstrating the adaptability of the process for handling packing-house sewage mixed with domestic sewage. Independent experiments also have been conducted by the packers. An interesting summary of the experiments and the results obtained is given in a paper presented Oct. 18 at the annual meeting of the American Public Health Association by Mr. Langdon Pearse, division engineer, in charge of sewage disposal investigations of the Sanitary District of Chicago. Mr. Pearse's paper practically in full follows.

The experiments of the Sanitary District have been conducted on a mixed domestic and packing-house sewage (Center Ave. sewage) containing by volume perhaps 25 per cent of domestic sewage. The experiments of the packers have been conducted on the effluent from individual houses, containing considerably higher amounts of suspended matter as well as organic matter in solution (see Table I).

Testing Station, Sanitary District of Chicago.—The activated sludge plant originally consisted of a rotary screen, four tanks in which the sewage is aerated, one tank for settling the aerated sewage, one sludge storage tank, two blowers with motors for supplying air, a sludge pump for returning the sludge to the aeration tanks from the settling tank, or the sludge storage tank, and a Venturi meter with recording apparatus for determining the quantity of air used.

The rotary screen is of the Weand type, cylindrical in shape, 2 ft. 4 in. diameter by 4 ft. 8 in. long, covered with 30 mesh brass wire screen, supported on ½-in. mesh screen. In the summer of 1917 the 30-mesh screen was replaced by a 20-mesh.

The four aeration tanks are each 6x23 ft. in plan, 12 ft. deep, inside dimensions, of 3-in. Oregon fir, well bolted together, with air distributors of filtros plates set in hopper bottoms of concrete faced with hollow tile. The plates are arranged differently in each pair of tanks. The ratio of plate area to tank area is approximately 1 to 6.3 in both the tanks with one row of plates down the center and those with the rows transversed to the length of the tank. After remodeling, the effective plate area was found to be 1 to 8. The capacity of each tank is about 11,000 gal. to the flow line. The tanks were first connected in series and provided with inlet and drain pipes, so that they can be operated separately on the fill-and-draw plan, as well as a whole with continuous flow. The air system is arranged with a main header to each tank, from which branch pipes feed each set of plates. Three small Venturi meters are provided to set on the main header lines in a by-pass to check up the flow of air to each tank.

The circular tank is 12 ft. in diameter with 12-ft. staves, built with a hopper bottom of the Dortmund type, originally with a slope of 0.6 vertical to 1 horizontal. The sewage enters the tank in the center near the bottom, the settled sewage passing off from the top around a peripheral weir. As the length of the weir is great and the sheet of water passing over proved very thin, "V" notches were cut in the crest to facilitate adjustment. The tank is provided with a sludge pipe for discharging sludge onto the drying beds, and a suction pipe to the sludge pump.

An old circular Dortmund tank, 8 ft. outside diameter, with 10 ft. staves, has been fitted up as a sludge storage tank. It can also be used as a settling tank in connection with one of the aeration tanks.

Two rotary blowers of the Connersville make, Boston type, belt driven, supply the air for the plant, one with a capacity of 300 cu. ft. per minute against a pressure of 6 lb. per square inch, driven by a 20-H.P. motor, the other with a capacity of 150 cu. ft. per minute against a pressure of 10 lb., driven by a 10-H.P. motor.

After considerable experiment, the settling tank was remodeled and the bottom hopper slope made 60° with the horizontal. A straight flow settling tank was also added, with steep hopper bottom slopes. Later the plant was changed again to permit of separate aeration of the sludge followed by settling before pumping the concentrated sludge back to mix with the incoming sewage. The period of aeration in contact with the sewage has been cut. The amount of air used is somewhat less than when the sludge was aerated entirely in contact with the sewage.

Summary of Activated Sludge Results.—The Sanitary District experiments on the activated sludge up to March, 1917, have shown that the following conditions must be met:

The sewage should be screened with a fine mesh screen; 30-mesh has been used. This removes from 600 to 1,000 lb. of dry material per 1,000,000 gal. of day flow.

The screened sewage can be aerated in continuous flow tanks using 4 cu. ft. of air per gallon of sewage, with an 8-hour contact period of sewage and activated sludge. This will produce an effluent, practically stable in summer conditions.

Sufficient sludge storage capacity in the aeration tanks should be provided to care for at least 140 per cent of the sewage entering the tanks. Actually from 40 to 80 per cent of the incoming flow is returned from the settling tanks, as a mixture of sludge and sewage.

The depth of the tanks has been taken at 16.5 ft. over the plates. The air distribution proposed is through filtros plates set in unit boxes of cast-iron, the ratio of filtros plates to the superficial area of the tank is 1 to 6.

The system provides the following approximate recovery of solids:

Grease as scum, 360 lb. per 1,000,000 gal.; as grease, 47 lb. per 1,000,000 gal.

Screenings, 600 to 1,000 lb. of dry material per 1,000,000 gal. of day flow.

Sludge, 2,000 to 3,000 lb. of dry material per 1,000,000 gal.

Testing Work. Armour & Co., Swift & Co., Wilson & Co.—Armour & Co. have made an extensive study of the treatment of individual house effluents both on the hog house at Chicago and on the combined outfall for Armour and Swift at Fort Worth, Tex. The results sought have been largely from the standpoint of determining the availability of material recovered for fertilizer. The Chicago results approximate those of the Sanitary District.

At Fort Worth, however, a very strong sewage has to be handled, because owing to the scarcity of water, waste is cut to a minimum. The trend of the experiments as judged from published data and a personal visit to Fort Worth, indicates that for the strong packing-house waste at Fort Worth—

Preliminary screening is necessary; 32-mesh wire screen has been used.

Preliminary sedimentation, accompaned by grease removal is desirable.

Dilution of the strong sewage will facilitate treatment.

In the aeration of the sludge contact with the liquid, 35 per cent sludge is desirable.

Re-aeration of sludge in a separate tank improves the sludge.

A stable effluent, well clarified, can be made.

The air consumption will be high, averaging from 6 to 9 cu. ft. of air per gallon of sewage with a 10-hour period of contact.

The use of acid in de-watering the sludge coagulates the sludge both quickly and readily, reducing the moisture content below 85 per cent.

Wilson & Co. (when known as Sulzberger Sons Co.) ran a small testing plant on the effluent of part of the packing house. Quantitative data is not obtainable, but examination showed clarification accompanied by recovery of solids.

Swift & Co. have built an extensive experimental plant on a sewer containing typical concentrated packing-house sewage. Although practically completed a year ago, the plant has not been operated to date, owing to press of war business.

Arrangement of Tanks.—The best arrangement of plant is not yet determined. Two schemes have been tried by the Sanitary District, one in which the sludge is aerated entirely in contact with the sewage, the other in which the sludge and sewage are aerated for a short time, the settled sludge, however, being re-aerated and re-settled before return to the initial point. The latter arrangement has shown somewhat smaller requirements in the amounts of air, and a reduced volume of sludge to be returned.

Stability of Effluent.—The amount of air noted in the experiments of the Sanitary District (4 cu. ft. per second per gallon of sewage) is apparently sufficient to produce a practically stable effluent in summer weather. In the winter, with the same amount of air, the effluent is of lower stability, when tested by incubation at room temperature. If a stable effluent is then required, 6 cu. ft. or more of air per gallon of sewage may be needed, according to the temperatures of the sewage and air.

Mixed vs. Undiluted Wastes.—Although the evidence to date is not absolutely conclusive, the indications are that a mixed domestic and packing-house sewage is more amenable to treatment than the strong packing-house sewage. This indication is apparently confirmed by the results at Fort Worth.

Air Distribution.—The distribution of the air appears at present to be best served by the use of filtros plates. Perforated pipes have been tried both at Chicago and Fort Worth. More air is required than with the filtros. The ratio of gross area of plate to tank area at Chicago was 1 to 6.3 with net area of 1 to 8. At Forth Worth, 1 to 7 has been used.

Baffling and Agitation. Tank Design.—Considerable study is required on both domestic and industrial sewage to determine the best design of tanks. In this connection the design of the bottom of the aeration tanks deserves attention. In England, Jones and Attwood have worked out a saw-tooth design. In the United States, Mordell at Milwaukee has worked out a design with a curved bottom, the plates being placed eccentric to the center of the tank. At the Chicago testing station simple baffling has been tried, with different arrangements of shallow hoppers in the bottom. No directly comparable results are available.

Sludge Settling.—Following aeration of the mixed sludge and sewage, the sludge is settled out. The experience of the Sanitary District indicates that the period may be short, ½ to 1 hour, and that the bottom slopes of hopper bottom tanks should be about 60° while the horizontal velocities should be low. The sludge may be removed continuously by air lift or centrifugal pump. Flat slopes around 45° or lower appear to encourage "hanging" and consequent septic conditions. A straight flow settling tank worked.

The required settling period, however, depends vitally on the condition of the sludge and may vary also with the season of the year.

Sludge Treatment.—The handling of the sludge is probably the most difficult problem of all. In the Sanitary District work, with screened sewage, exclusive of screenings, about 46,500 gal. of liquid sludge, containing 99.2 per cent water accumulated per 1,000,000 gal. of sewage over a period of nine months. This is equivalent to 2,420 lb. of dry solid per 1,000,000 gal. The amount of dry solids per 1,000,000 gal. appears to vary between 1,100 and 4,500 lb. exclusive of screenings. The screenings caught on a 30-mesh screen will vary from 500 to 1,200 lb. of dry material per 1,000,000 gal. of day flow. During a period of 6.5 months the reduction of suspended matter was 2,820

TABLE I.—TYPICAL ANALYSES OF PACKING HOUSE SEWAGE—PARTS PER MILLION.

Source.	—Nitrogen as— Total org.	Free ammo.	Nitrites.	Nitrates.	Oxy. cons.	Chlorine.	—Suspended matter.— Tot.	Vol.	Mixed.	Alkalinity.
Center Avenue[1]—										
Day	79	22	0.49	3.04	268	1100	605	461	144	291
Night	...	...	....	....	...	....	163	112	51	...
Halsted Street[2]	260	28	....	....	257	365	428	344	84	340
Ashland Avenue[3]—										
Day	73	20	0.21	1.97	245	920	860	657	203	358
Night	34	18	0.08	0.86	70	537	...	...	...	237
Armour & Co. Hog House[4]—										
Day	..	...	....	....	...	...	903	...	...	...
Night	...	...	....	....	...	...	449	...	...	...
Swift & Co.[5]—										
Day	56	26	....	....	290	...	937	815	122	278
Night	21	9	....	....	92	...	222	181	41	210
Wilson & Co[6]	194	78	....	....	466	...	1040	990	50	395
Armour & Co., Fort Worth[7]	...	...	....	....	...	...	3090	...	...	...

Note:—Chicago analyses from Report Industrial Wastes, 1914.

[1] Average, 1913. [2] July 28, 1911, 4 hours. [3] Fourteen day samples, ten night samples, 1913. [4] May 23 to 26, 1911. [5] June 6 to 10, 1911. [6] June 29 to July 1, 1911. [7] Verbal statement of W. C. Moore, Chemist, Armour & Co., Fort Worth.

TABLE II.—TYPICAL ANALYSES OF SCREENINGS AND SLUDGE—THE SANITARY DISTRICT OF CHICAGO.

Source.	Per cent moisture.	Calculated to dry weight. Fixed.	Volatile.	Org.	Ether.	Soluble acidified.	Remarks.
Screenings	80.7[1]	4.7	95.3	2.18	5.9	9.4	Average, 3 mos.
Sludge	99.15	37.4	62.6	4.17	6.00	9.25	Average, 9 mos.

[1] Moisture content average of 9 months.

lb. as against a sludge removal of 2,680 lb. of dry material per 1,000,000 gal.

The essential point is to remove the water. Various expedients have been tried, which may roughly be subdivided into (1) settling, (2) the use of coagulants, including both alkali and acid, (3) filter pressing. Centrifuging has not yet been tried at Chicago.

With very liquid sludge, direct filter pressing is difficult, owing to the large amount of liquid to be handled. Preliminary treatment by settling with or without acidification is very helpful. Quiescent settling from 3 to 6 hours will reduce the moisture content to 98 to 98.5 per cent. The addition of about 6 lb. of sulphuric acid per 1,000 gal. of sludge (containing 98 per cent moisture) seems to aid in filter pressing, and makes a sludge which leaves the cloths cleaner. A 2.5 hour pressing with acid treated sludge is equivalent to 3½ to 4-hour pressing with settled sludge. Moreover, acid treated sludge apparently keeps better and shows a somewhat higher nitrogen content.

The effect of acid on activated sludge is not at all the same in different places. Apparently on the Sanitary District sludge, the effect of acid is a minimum, whereas at Fort Worth, on packing-house activated sludge, the addition of acid produces a rapid coagulation, with immediate flotation of the sludge, the moisture content being quickly reduced. The water used in the packing houses there is very high in alkali. The sludge can be further reduced by drainage and re-treating to about 85 per cent moisture or lower. This phenomena does not occur at Chicago. Furthermore, it is estimated at Fort Worth that about 11,000 lb. of dry material can be recovered per 1,000,000 gal.

Plain settling has considerable value in reducing the moisture content. However, the effectiveness is conditioned on the condition of the sludge. The settling is not as marked as on domestic sewage at Milwaukee or in packing-house sewage at Fort Worth.

Filter pressing has been tried by the Sanitary District on a small "Simplex" press, with plates 15 by 15 in. square, loaned by the Simplex Ejector Co. and demonstrated by Mr. W. Buckley. This press was the one used at Milwaukee, with the addition of six radial ribs on each plate. The plates in the press have perforated steel strainer plates over the corrugations. Cakes from ⅛ to 1½ in. have been made in from 2 to 4 hours' pressing, with pressures varying from 20 to 150 lb., according to the character of the sludge and the preparatory treatment. Occasional steaming helped in keeping the cloths clean. The moisture content of the cake was varied, in general being around 80 per cent.

Sludge Analyses.—There appears to be considerable fertilizer value in activated sludge. Analyses show a high nitrogen content, compared to the screenings (Table II). Occasional analyses show press cake, particularly with acidified sludge, running from 5 to 6 per cent of nitrogen on the dry basis.

Screening.—The value of fine screening as a treatment preliminary to aeration is worth consideration. The Sanitary District experiments show that a 30-mesh screen will remove from 500 to 1,200 lb. of dry material per 1,000,000 gal. of day flow. The screenings contain about 80 per cent moisture after natural drainage. The nitrogen content is low, equivalent, perhaps, to barnyard manure (Table II). The material is largely paunch manure. The material removed is the coarser suspended matter, consequently the amount of depositing material is lessened, which may tend to collect in the depressions of the aerating tanks. From the operating standpoint the removal of this material by screens seems desirable, as it is largely inert, of vegetable origin and slow to decompose. From the standpoint of handling the sludge, however, when the screen is running, the sludge is somewhat harder to press. The screenings seem to act as a fibrous binder which aids pressing.

Recoveries.—The general indications at Chicago are that grease and fertilizer may be recovered. The grease may be worth about 4 and 7 ct. a pound at normal and war prices. The activated sludge, dried, if containing regularly 5 per cent of ammonia, may be worth about $12 per ton dry, under normal conditions, or possibly $18 per ton under present war conditions.

Odors.—The activated sludge testing plant operated at Fort Worth, at Chicago by Armour & Co. and by Sulzberger & Co., and by the Sanitary District have been remarkably free from odor. The sewage tested in all cases has been fresh.

Further Developments.—Further development in the activated sludge process appears to be along the lines of reducing the amount of air used, improvement of settling tanks, and the more rapid reduction of water content of the sludge. Such development will tend to reduce both construction cost and operating charges.

The reduction in the use of air may be obtained along the lines of development in the design of tanks, to promote mixing and distribution of air, and possibly along the line suggested in England of intermittent application of air.

The improvement of settling tanks is in a transition stage. The steep hopper bottomed tanks are effective. However, other devices may be workable, such as the Dooer tank, particularly where the returned sludge is re-aerated separately and re-settled before return to the inlet.

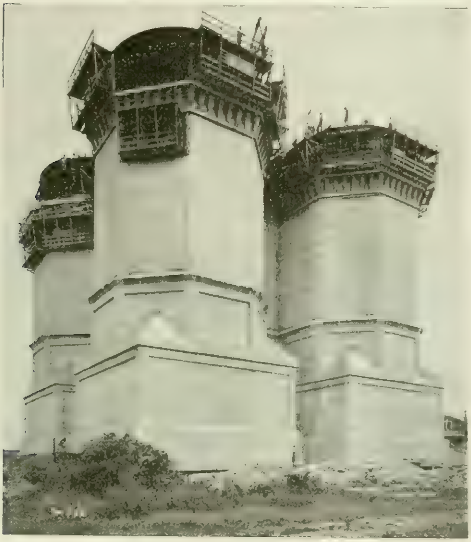
Ways and means of reducing more rapidly the water content of the sludge should be studied, either in preparation for filter pressing or as a direct preliminary to drying. This is a complex problem, verging on the domain of physical chemistry.

Conclusion.—The activated sludge process offers the best promise of a solution of the problem of treating packing-house waste of any suggested up to the present time. For the study of conditions in Chicago the construction of a unit plant has been recommended to handle 1,500,000 gal. per 24 hours, to obtain working results on a large enough scale to determine the design of the final plant.

Coal Carried by Artificial Ohio River Floods.—By means of an artificial rise, started on Oct. 18, 1917, at Dam No. 7, Ohio River, and augmented by water from the Muskingum, Kanawha and Big Sandy Rivers, more than 80,000 tons of coal from the Kanawha River were delivered to Cincinnati and other river cities. Every available towboat and barge was used in this movement, even the small harbor boat of one of the coal companies being utilized to bring down 4 coal boats, and a show-boat pusher was chartered to bring down 10 barges; 14 tows of more than 200 craft were in the movement. Last August, during a period of extremely low water, a fleet of barges, which carried 13,000 tons of coal, was successfully moved by this means. About a year ago two similar experiments were carried out successfully at a time when there was a shortage of coal in Cincinnati.

Steel Water Tanks Encased in Ornamental Concrete Shell

The Water Department of the city of Cincinnati, having received complaints and opposition from real estate holders regarding the appearance of large steel water standpipes, has recently taken steps to improve conditions from an architectural standpoint by the erection of ornamental concrete structures around the standpipes. The first work of this kind was done at the Western Hills tanks, and proved so successful that steps were taken to encase the tanks forming the Eastern Hills reservoir. The group at this location consists of five steel standpipes, 40 ft. in diameter by 100 ft. high. The four outer tanks are placed at the corners of a 60-ft. square, with the fifth tank in the center. The accompanying illustration shows the Eastern Hills tanks almost completed. When finished the top of the structure will present the appearance of the battlements of an old fort.



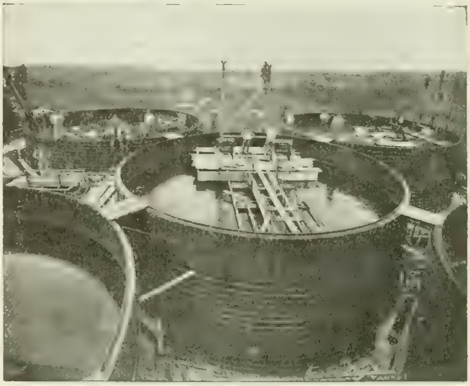
Partially Completed Ornamental Concrete Encasement of Steel Water Tanks.

Construction Method.

After the steel cylinders had been erected they were filled with water so that they would have the same shape as when in actual service. It was feared if concrete was poured while they were empty, slight changes in shape might take place when the water was let in, and this would cause cracking of the concrete shell.

The forms for the first section setting were supported on the foundation and braced to the ground. Forms for subsequent settings were raised from floats which can be seen in the illustration. A lifting derrick will be seen at the extreme right of one of the illustrations. The derrick rests on a two-boom crab-operated rig supported on empty oil barrels on the water surface of each of the four corner tanks. Since each panel weighs about a ton it is practically impossible to pick this weight from a floating platform of reasonable cost which would fit in a 40-ft circle. Flotation is therefore used only when rotating the rig from one form to the next. In order to support the load the rear end of each float is blocked down from the Z-bar which forms the top of each tank, and the forward end is held by hooks over this Z-bar.

The foundation plan was about 100 ft. on the side and from 270 to 300 cu. yd. of concrete is required for a complete lift, this to be distributed over a considerable area. It was therefore possible, by using stop planks, to concrete one-half of the structure while the horizontal reinforcing was being set and while the forms were being raised on the other half, thus the mixing plant was kept going at the rate of 100 cu. yd. or more a day. The total volume of concrete placed exclusive of footings was about 3,800 cu. yd.



Floating Arrangement for Raising Forms.

The hoisting tower is double, one side being used for the concrete skip and the other having an elevator for the workmen. The tower also has a boom for raising the reinforcing.

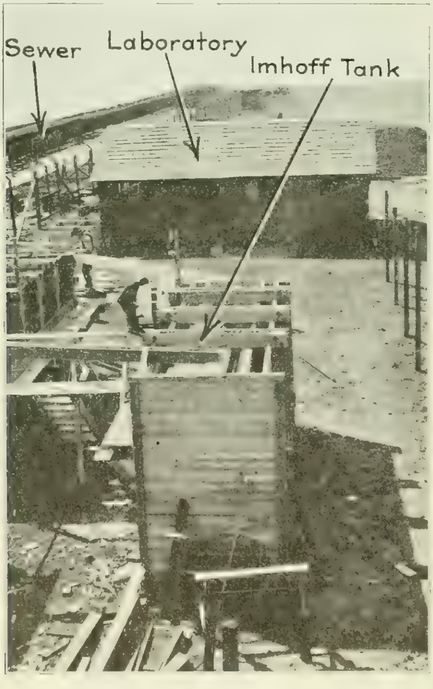
The tanks were designed and built under the direction of J. A. Hiller, General Superintendent of the Cincinnati Water Works, T. J. Mulloy, resident engineer, being in charge. The Ferro Concrete Construction Co., of which W. P. Anderson is president, is the contractor. J. Hodges is in charge of the work for the contractor while the forms and methods of construction were designed by Henry D. Loring, engineer for this firm.

"Gas and Flame" Battalion.—A "gas and flame" battalion is now being organized for service with U. S. Troops. Although the gas and flame service was authorized as recently as Oct. 15, rapid progress has been made in organization, due to its promise of early service at the front and on account of its special appeal to men experienced in civil trades which lend immediate qualifications for this special work. It is announced that there is opportunity for a limited number of enlistments for the following classes of men: Chemists, gas engineers, plumbers, electrical experts, pipe fitters, interpreters, mechanics, chauffeurs, explosive experts, cooks, gas experts, blacksmiths, carpenters, clerks, and muscular, quick-thinking, resolute men between the ages of 18 and 40 years for pioneer soldier service of high character. Any man possessing the necessary qualifications may volunteer at any recruiting station of the country by asking to join the Thirtieth Battalion, Gas and Flame, forming at Washington.

The Sewage Experiment Station of New Haven, Conn.

A very complete sewage experiment station has been placed in operation recently by the city of New Haven, Conn. The following description of the station is taken from a paper presented at the Boston meeting of the American Chemical Society by Mr. F. W. Mohlman, chemist and engineer in charge:

New Haven is an important manufacturing city of 150,000 inhabitants. The sewerage is on the combined system. Wastes from most of the larger factories are discharged into the East Street sewer, which has an average dry-weather flow of 13,000,000 gal. per day. Since it was thought that trade-wastes might interfere with the treatment of this sewage it was decided to locate the experiment station at the outfall of this sewer. The sewer discharges into tide-water and at high tide the sewage is backed up in the sewer for a distance of several blocks.



Sewage Experiment Station of New Haven, Conn.

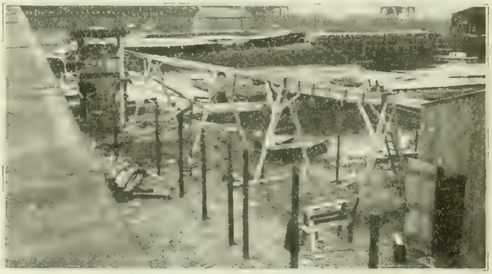
The sewage for the testing station is pumped by a bucket-elevator, which was erected in a concrete forebay at one side of the sewer. The sewage is deflected into the forebay by a galvanized-iron deflector built out nearly to the center-line of the sewer, and flows back into the sewer at the lower end of the forebay. It was believed that a fair sample of the sewage could be obtained in this way, including the floating solids and grease, and that the suspended solids would not be broken up to as great an extent as if a centrifugal pump were used. Operation of the elevator has shown that it fulfills these expectations. It delivers approximately 150,000 gal. of sewage per day into a hopper-shaped receptacle from which it flows over to the station through a wooden flume supported by wooden bents. Before flowing into the weir-box, where it is measured, the sewage passes through a grit-chamber 15 ft. long, 12 in. deep at the inlet end, 4 in. deep at the outlet end and 4 in. wide, with a detention period of 0.24 minute. The velocity of the sewage is checked to 0.7 ft. per second at the inlet end, increasing to 2.1 ft. per second at the outlet end. This velocity is so high and the detention period so short that very little grit has been removed from the sewage.

Following the grit-chamber there is a butterfly valve in the flume which is automatically controlled by a float in the weir-box. This butterfly valve keeps the sewage at a constant level in the weir-box, the excess sewage being deflected over weirs 4 ft. long cut in the sides of the flume. The apparatus for maintaining a constant level was constructed by Wallace & Tiernan of New York City.

From the weir-box the sewage flows to the various tanks over adjustable weirs, small amounts of 10,000 gal. per day being measured by 60° V-notch weirs, a larger amount, 100,000 gal. per day, by a rectangular weir 7½ in. long.

The processes being studied are: Activated-sludge. Imhoff. Miles acid. Screening. Disinfection by liquid chlorine.

The activated-sludge experiments are on the continuous-flow basis. The aerating tank is 16 ft. long, 4 ft. wide and 8 ft. deep. At the bottom of the tank the sides slope at 45° to a trough 1 ft. wide which runs the full length of the tank. An iron frame in which are cemented 15 filtros plates is cemented into this trough. The air is admitted at the inlet end of this trough, and the water which filters through the plates can be drawn off at the outlet end. The air is compressed to 3.5 lb. pressure by a Nash hydroturbine having a capacity of 20 cu. ft. of free air per minute. It is measured by means of a Venturi tube.



Bucket Elevator and Wooden Flume for Delivery of Sewage to Station.

The settling tank is 4 ft. by 4 ft. in plan, and 12 ft. deep to the bottom of the hopper. This hopper slopes at 60° to a sump in which is cemented a 3-in. ell connected to the suction of a centrifugal pump. Sludge is pumped back to the aerating tank where it is measured in an orifice box. A baffle 7½ ft. deep extends across the center of the settling tank. This baffle was first placed 3 ft. from the inlet weir and 1 ft. from the outlet weir, but the upward velocity of the effluent carried particles of sludge over the outlet weir. Since placing it in the center of the tank no sludge has been lost in this way. The theoretical upward velocity is now 2.4 in. per minute; it was formerly 4.8 in. per minute. The capacity of the aerating tank is 3,100 gal., the settling tank 1,150 gal. At present, while treating 17,000 gal. of sewage per day with 50 per cent as much sludge returned, the aeration period is 3 hours, the settling period 66 minutes.

The Imhoff tank is 16 ft. long, 4 ft. 6 in. wide and 11 ft. 6 in. deep. The flowing-through chamber extends the full length of the tank, with gas vents 8 in. wide on each side. Its capacity is 840 gal., giving a detention period of 2 hours when treating 10,000 gal. of sewage per day.

The Miles tank is 16 ft. long, 3 ft. 6 in. wide and 4 ft. deep, having a capacity of 1,680 gal. When treating 10,000 gal. per day the theoretical detention period is 4 hours. Liquid sulphur dioxide in cylinders is used for acidifying the sewage, supplemented at times by gas produced by a sulphur burner.

Screening experiments were planned with the expectation that an experimental Riensch-Wurl screen could be obtained, which was to be operated at the rate of 100,000 gal. per day. In view of the impossibility of obtaining this screen, experiments with a mechanically-operated screen had to be abandoned. Fixed screens of 30-mesh monel metal wire cloth are used in a screen chamber through which raw sewage flows at the rate of 100,000 gal. per day. The screens are removed when the loss of head reaches 2 ft., and are cleaned by hand. The operation of the screens is discontinuous, approximately 3,000 gal. of sewage being screened for one experiment.

The effluents from the Imhoff tank, activated-sludge tank, and screening chamber run through baffled tanks where they are treated with liquid chlorine. The periods of detention are from 2 to 5 minutes.

Minnesota Regulation Relating to Sanitary Improvements

The Minnesota State Board of Health has recently adopted a regulation requiring that plans and specifications for water supply, sewerage and refuse disposal for public use must be submitted to the Board for its approval. The regulation follows:

> No system of water supply, sewerage, or refuse disposal for public use, which affects or tends to affect public health, shall be installed, nor shall any such existing system be materially altered or extended, until complete plans and specifications for the installation, alteration, or extension, together with such information as the State Board of Health may require, have been submitted in duplicate and approved by the Board so far as relates to their sanitary features. All construction shall take place in accordance with the plans as approved, whether with or without modification. Whenever any governing body of any municipality having charge thereof shall determine that there shall be any material change in the plans, construction, or operation of any such systems, such governing body shall submit to the State Board of Health, in duplicate, a detailed statement of such action or such contemplated changes before it shall enter upon the making of such changes or enter into any contract therefor or any part thereof, and then such changes shall only be made after approval as to all matters liable to affect public health, by the State Board of Health.

Commission Government and City Managers.—The commission form of government and city manager plan were voted on by a number of cities at the Nov. 6 election. East St. Louis, Ill., by a vote of 2 to 1 adopted the commission form of government. Waltham, Mass., also adopted the commission plan and will have five commissioners who will appoint a city manager. Winchester, Mass., voted against the adoption of the town manager system, and Lynn, Mass., which accepted the commission form in 1910, adopted a revised charter under which it goes back to the city council plan. Altoona, Pa., elected city councilmen pledged to employ a city manager. Collingswood, N. J., adopted the commission form of government as did Clarksburg, W. Va.

A Discussion of the Fundamental Principles of Water Works Valuation*

If rates are to be established, the valuation should be based on the fair and legitimate investment. If the financial transactions have been honest and the works have been built and operated according to average or ordinary practice, and the book records are in good shape, the historical cost should be taken and the rates should be such as will enable the utility to receive a fair return on its investment from the beginning; so, therefore, if the utility has not as yet received a fair return and is depending upon the future to attain that object, the past losses must be added to the historical cost.

The logical method of procedure is to tabulate for each year:

The plant cost (a).
The operating expenses (b).
The estimated depreciation on the physical plant (c).
The gross revenue (d).
The fair return (e) and the valuation (v).

Then $e = (a + b + c - d)\frac{p}{100}$ and $v = a + b + c + e - d$,

where p = the fair return decided upon as a percentage on the investment.

By this process it is seen that a reduction of any of these items—a, b, c, e—or an increase of the item, d, will decrease the valuation, and vice versa. If the utility has earned a fair return and no more,

$$b + c + e = d, \text{ and}$$
$$v = a.$$

If it has earned more than a fair return, v, will be less than, a, and if it has earned less than a fair return, v, will be more than, a.

Under this plan no allowance would be made for accrued depreciation, obsolescence, or fluctuation of value of real estate, water rights, or other property. Neither would allowance be made for service pipes or street pavements, unless their cost were borne by the water company.

In the writer's judgment, this is the method of determining the valuation that should be used for the establishment of rates or where the property is being condemned by the municipality.

The following are some of the reasons for this conclusion: Most water-works systems were established before the advent of State control and regulation of rates. The owners knew that the works would have to go through a period of development and could not pay for a considerable number of years. They had reason to believe they would eventually pay a sufficient return to make up for early losses, and, therefore, if the city should condemn, they would receive at least the past cost plus a reasonable rate of return on said cost; otherwise the city would be taking private property without just compensation.

The market value of a property is dependent upon its future net revenue, which depends upon its rates. Without State regulation these elements of market value are capable of being predicted by water works builders and investors with as much certainty as with other industries. But just as soon as the State undertakes to fix rates it must, presumably, do so with justice. That means that the public shall be protected against undue profits to the water company and the company shall be protected against loss, which will be the case unless it earns a fair return on the investment corresponding to water works practice. Hence the valuation must be based on investment and not on estimated cost of reproduction at present prices. Neither can it be based on market value, because the market value cannot be established until the rates have been fixed for a long period in the future.

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*From a paper by J. W. Ledoux, in October Journal of the Engineers' Club of Philadelphia.

Evidently there are serious difficulties connected with the practical application of this method, otherwise it would be more universally recommended for the two conditions above cited. A few of these difficulties are as follows: The accounts of the water company may be lost or manifestly in error. The construction and operation of the works may have been grossly mismanaged. The cost of the physical plant and of operation may have been much too high or too low in comparison with ordinary practice. The property may have changed hands at a price that was grossly different from a fair valuation. For all these cases the valuator will have to use his best judgment to supply missing or defective data.

Assuming that all the items represented in the formula by, a, b, c, and, d, are satisfactorily determined, what shall be taken for, p, the percentage of fair return?

A public water works, whether owned by a private company or a city, is one of the most important and vital elements upon which the health and welfare of the community depend. The responsibility for its safe operation is great, and any failure in the performance of its functions is damaging to the community depending upon it. To be operated well and continuously, its financial success must be certain. To maintain the desired standards and well provide for the growing demands, money must be readily available. This means that investors in its stocks or securities must be assured of fair returns, and that there is no danger of public confiscation by under-valuations or inadequate rates.

Heretofore the percentage of returns on this class of property has been far less than on other public enterprises of less vital importance, and there is a tendency on the part of the public service commissions to squeeze down the valuations and consequent return on the investment to figures that are a grave menace to this class of property.

Recognizing this condition, the holders of wealth are reluctant to make such investments unless there be assured earnings far in excess of a legal rate of interest. Men experienced in water works management and finances refuse to purchase these properties except on a 9 or 10 per cent basis. As a consequence, it will be impossible to make necessary improvements to meet the growing demands of the communities, unless the commissions and tribunals make it their business to adopt an entirely different attitude, such that the water works investments will again be considered as attractive and safe as they were prior to the time when they came under commission regulation.

TABLE I—VALUATION BASED ON THE ACTUAL COST, INCLUDING A FAIR RETURN OF 8 PER CENT ON THE INVESTMENT, AND 1 PER CENT DEPRECIATION

Year	1 [illegible] expenditures from year to year	2 [illegible] taxes and insurance [illegible] interest [illegible] depreciation	3 Gross receipts from operation	4 Total [illegible] 1 + 2 + [illegible]	5 [illegible]	6 Fair return 8 per cent [illegible] 1 per cent depreciation [illegible]	7 Valuation of plant at end of each year 5 + 6
1889	$42,000.00			$42,000.00	$42,000.00		$42,000.00
1890	6,535.40	$2,025.39	$2,249.67	50,560.79	48,311.12	$4,347.99	52,659.11
1891	2,879.92	1,885.36	3,606.66	57,424.39	53,817.73	4,843.59	58,661.32
1892	6,936.30	1,819.99	5,101.43	67,417.61	62,316.16	5,608.43	67,924.63
1893	1,903.61	1,955.96	6,186.59	71,784.20	65,597.61	5,903.78	71,501.39
1894	1,425.85	1,559.92	7,128.58	74,487.16	67,358.58	6,062.26	73,420.84
1895	7,780.83	2,020.84	8,152.77	83,222.51	75,069.74	6,756.27	81,826.01
1896	1,607.65	3,437.83	9,056.45	86,871.49	77,815.04	7,003.35	84,818.39
1897	10,747.41	3,025.36	9,716.35	98,591.16	88,874.81	7,998.73	96,873.54
1898	1,290.32	4,470.75	9,562.28	102,634.61	93,072.33	8,326.50	101,398.83
1899	1,862.82	2,089.35	10,413.49	105,351.00	94,937.51	8,544.37	103,481.88
1900	[illegible]	[illegible]	10,803.68	107,494.39	96,690.71	8,702.16	105,392.87
1901	2,870.80	4,596.83	12,774.14	112,860.50	100,086.36	9,007.77	109,094.13
1902	3,279.23	4,151.63	11,627.44	116,524.99	104,897.55	9,440.78	114,338.33
1903	2,779.56	5,252.57	13,207.14	122,370.46	109,163.32	9,824.70	118,988.02
1904	4,332.97	6,284.04	14,363.17	129,605.03	115,241.86	10,371.77	125,613.63
1905	1,636.30	5,885.11	14,272.20	133,135.04	118,862.84	10,697.65	129,560.49
1906	7,262.56	6,196.80	16,257.90	143,019.85	126,761.95	11,408.57	138,170.52
1907	26,412.27	8,209.25	17,772.66	172,792.04	155,019.38	13,951.74	168,971.12
1908	217.71	7,330.24	17,903.87	176,519.07	158,615.20	14,275.37	172,890.57
1909	522.41	6,631.18	19,253.54	180,044.16	160,790.62	14,471.15	175,261.77
1910	6,543.13	7,585.01	19,277.86	189,389.91	170,112.05	15,310.08	185,422.13
1911	11,816.56	4,615.73	21,141.01	201,854.42	180,713.41	16,264.21	196,977.62
1912	3,560.60	5,464.42	23,856.75	206,002.64	182,145.89	16,393.13	198,539.02
1913	7,250.51	8,785.21	26,599.76	214,574.74	187,974.98	16,917.75	204,892.73
1914	13,929.53	6,389.78	27,204.29	225,212.04	198,007.75	17,820.70	215,828.45
1915	14,602.90	9,646.46	27,403.57	240,077.81	212,674.24	19,140.68	231,814.92
1916	11,518.71	6,698.41	28,775.06	250,032.04	221,256.98	19,913.13	241,170.11
1917	369.93	2,036.63	1,080.62	243,576.67	242,496.05	5,456.16	247,952.21

[illegible] for Column [illegible] are for end of previous year (Valuation as of Jan. 1, 1917, by this method, $241,170.11).

It would therefore seem that for the present, at least, 8 per cent should be taken as a fair return. For future years, when water works investments are again looked upon as stable and safe under commission ruling, it may be that a much lower per cent will attract capital, even approximating as low as obtains for municipal securities.

To make the process of valuation, outlined in Table I as simple, definite and specific as possible, a typical case of a small water works plant is taken as an illustration. It happens to be a fairly successful works, which has actually earned an average of over 7 per cent on the investment from the beginning.

The foregoing discussion refers to the case of establishing rates or condemnation of the plant by the municipality. The valuation so determined is not at all based on economic or market value, and therefore cannot be considered as synonymous with what has been designated as "fair value," but is more properly termed, "fair valuation," or "just valuation," and is applicable to those cases, not only in which the utility is under government regulation as to rates or subject to condemnation, but where the exercise of either one of these functions is the purpose of the valuation.

We next come to the case wherein a municipality desires to acquire the utility. It may have the option of negotiating with the owners of the utility, of exercising its right of eminent domain or of building its own plant. Let us assume the municipality prefers not to condemn on account of the danger of too high a valuation, so that a satisfactory price must be agreed upon or the municipality builds its own works. The municipality calls in an experienced valuator and inquires of him as follows: "What can we afford to pay for the utility rather than build our own works?" The valuator naturally proceeds to estimate, at present prices, the cost of construction of an exactly equivalent plant, from which he deducts a proper allowance for accrued depreciation. To the remainder he adds the value of the acquired revenue and obtains a valuation based on the cost of reproduction—usually designated as "the cost of reproduction less depreciation plus going value." This method is entirely different from the first, and the resulting valuation is likely to be materially different. If the city did not have the right to build its own plant without first buying or condemning the existing plant, there would seem to be no logical justification for this method of valuation.

Let us assume, however, first, that the city has the right to build its works but cannot prevent the water company from continuing to operate, and, second, it has the right to build its own works, and as soon as the new plant is completed it can prevent the water company from continuing its business. The cost of construction will be the same in each case, but the "going value" will be materially different. In the first case it may be impossible for the city to acquire all, or even a substantial portion, of the revenue. So the city can afford to pay the water company a high price for the existing revenue rather than be subject to disastrous competition and economic loss. In this case the "going value" will be a maximum.

In the second case the city is sure to secure all the revenue within a few years after the new works are completed. If there is no other way to obtain water, most of the people will connect up the first year after the beginning of operation, and every one of the old consumers will be a patron of the new works within two or three years. However, the usual case is where the people can obtain water from wells or cisterns, in which case it may be several years before they are all connected up.

To determine or calculate what the "going value" should be for either of these cases, it is necessary to make a comparison of the financial operation of each plant from the present up to the time when the new plant is receiving the same gross and net revenues as the old plant is then receiving. The annual differences in favor of the old plant reduced to a present-worth basis will be the "going value." Some broad assumptions have to be made—the length of time required to build the new plant, the annual operating expenses, depreciation, interest, the gross revenue for each plant up to the time at which they are equivalent, and the value of money to be used in calculating the present worth. Most of these elements require judgment and at best are subject to uncertainty, but the computation is nevertheless perfectly legitimate and likely to reach much nearer the truth than to guess at the "going value" without any other basis of comparison. The prognostication of the future is very much aided by the graphical method. Curves are drawn to indicate the variation of gross revenue and operating expenses for the old plant, and these are extended into the future years, preferably by straight lines. From these straight lines an equation of the operating expenses is derived in the form—

$o = a + bR$, in which
o is the annual operating expenses,
R is the gross revenue,
a and b are constants

Substituting known values for o and R for two points on each of the straight lines, the constant values of a and b are obtained.

Next tabulate the estimated annual gross revenue for the new plant, from which the equation may be used to calculate the operating expenses. We now have sufficient data to complete the table. To reduce the net revenue differences to present worth, it would seem that for these cases the rate of interest which the municipality has to pay for money should be used rather than that which the water company should receive as a fair return.

The valuation so obtained will represent what the city can afford to pay rather than build its own plant.

It is evident that this method ought to produce the same result when it is approached from the water company's side. The question would then be, "What can it afford to take rather than let the city build its own works?" The answer would naturally be, "It cannot expect to receive more, and it should not receive less, than the city can afford to pay, and, hence, precisely the same method should be used and the same rate for money to calculate present worth."

In order to make the method of calculating "going value" more clearly understood and rationally presented, we have shown a typical calculation in Table II. We have assumed the physical cost of the plant to be $235,265. The diagram (Fig. 1) shows the gross revenue and operating expenses and curves of the corresponding estimated figures for the equivalent plant.

We assume that it would take a year to complete the construction of an equivalent plant, and that 6 years after the plant is completed it will have the same earnings and operating expenses as the present plant. The variations would be as follows:

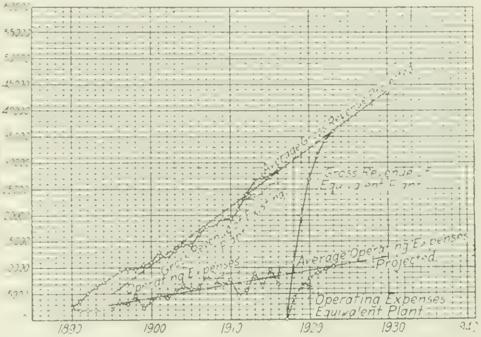

Fig. 1—Diagram for Gross Revenues and Operating Expenses for Use in Determining Going Value. 1917.

At the end of the first year after completion 30 per cent of the final gross revenue.

At the end of the second year after completion 35 per cent of the final gross revenue.

At the end of the third year after completion 75 per cent of the final gross revenue.

At the end of the fourth year after completion 87 per cent of the final gross revenue.

At the end of the fifth year after completion 96 per cent of the final gross revenue.

At the end of the sixth year after completion 100 per cent of the final gross revenue.

From the equation

$$o = a + bR.$$

taking values of, o, and, R, from the straight lines of the diagram, a, and, b, become $1,660 and 0.232, respectively, so that the final equation becomes,

$$o = \$1{,}660 + 0.232R.$$

From Table II the values of, R, are obtained and substituted in the equation, and the values for, o, are calculated for the equivalent plant.

We now have all the data for the gross revenue and operating expenses of the equivalent plant.

If the present plant is to be purchased, we will assume, afterwards to be verified, that the price will be

TABLE II.—CALCULATION OF "GOING VALUE."

	Given Data Present Plant.					Calculated Data Equivalent Plant.					
	Capital invested to buy old plant.	Gross revenue.	Operating expenses.	Interest on capital.	Net return.	Capital invested in plant.	Capital added to make up deficits.	Gross revenue.	Operating expenses.	Interest on capital.	Net return.
Jan 1, 1917	$276,740	....	....	....	....	....	....	....	....	....	....
July 1, 1917	276,740	....	....	....	....	$235,265	....	....	....	....	....
Dec. 31, 1917	276,740	$29,400	$ 8,500	$13,837	$ 7,063	....	$12,945	....	....	$ 5,882	$ 7,063
Dec. 31, 1918	276,740	30,500	8,700	13,837	7,963	....	13,733	$10,800	$ 4,160	12,410	7,963
Dec. 31, 1919	276,740	31,700	9,000	13,837	8,863	....	8,400	19,800	6,240	13,097	8,863
Dec. 31, 1920	276,740	32,700	9,300	13,837	9,563	....	3,990	27,000	7,910	13,517	9,563
Dec. 31, 1921	276,740	33,900	9,500	13,837	10,563	....	1,820	31,400	8,940	13,717	10,563
Dec. 31, 1922	276,740	35,100	9,800	13,837	11,463	....	591	34,300	9,620	13,808	11,463
Dec. 31, 1923	276,740	36,100	10,100	13,837	12,163	....	....	36,100	10,100	13,837	12,163

"Going value" = $41,479. Valuation of plant = $235,265 + $41,479 = $276,744.

$276,740, but if a new plant were built, which would require approximately a year for its construction, the cost would be $235,265, and the difference between the two is the "going value." Assuming, first, that the old plant would be purchased, the gross revenue and operating expenses, from the diagram, are found to be as shown at the left side of Table II and the interest on the purchase price per year at 5 per cent will be $13,837, so with these data we obtain the annual net return over interest charges. With the equivalent plant we assume that $235,265 for construction is borrowed uniformly during the first year, and therefore the interest during the year will be 5 per cent on the total amount for six months. Now let us assume that we apply each year to "capital added to make up deficit" a sufficient amount so that the net return over interest on amounts borrowed at 5 per cent will be exactly equivalent to the net return over interest on the present plant. If, at the end of 6 years, the entire difference between $276,740 and $235,265 is used up for this purpose, then we will have made a correct assumption as to the value of the old plant, and the difference between that and the cost of construction of the new plant will be the "going value." The Table (No. II) will make this clear.

It will, of course, be understood that several trial calculations for the "going value" must be made, and the table worked out from the existing data in each case until we find a sum that will be just sufficient, so that at the end of 6 years the two plants will be earning the same without any extraction for "capital added to make up deficit." In this case the difference between the purchase price of the old and the cost of construction of the new plant is $41,479, representing the "going value," and the steps are clearly shown in the table.

The next important case is where the city neither has the right to condemn, grant a new franchise, nor build its own works, so long as the water company furnishes good water and service, and the rates are established for a long and indefinite term of years. The city or some outsider desires to acquire the plant; what should be the process of valuation? Evidently an entirely different principle applies, for the water company cannot be forced to sell, cease operation, or relinquish any of its business. An appraiser is called in to make a valuation. After considering all the circumstances of the case he will naturally come to the conclusion that this is a case where the "market value" method applies. He is not interested in what it will cost to reproduce the plant, but he is interested in what it will cost to operate it, maintain it, and make the necessary renewals and improvements. He wants to know how the revenue is varying from year to year and what it is likely to be in the future. His inquiry does not extend beyond 30 or 40 years in the future, because he recognizes such remoteness to be in the realms of posterity. He then proceeds to draw graphs of the operating expenses during the past years and extend them 40 years into the future. To find out how the plant is likely to grow, he makes a similar graph of the plant costs. This curve will also be useful from which to figure depreciation. To determine the maintenance and necessary renewals, it will be sufficient and safe enough to make from the beginning an annual allowance of say eight-tenths of one per cent on the total plant cost up to the end of the previous year, for if the plant is earning more than 5 per cent the allowance for depreciation can be invested in its improvements.

He now makes a graph for past and future gross revenue, and this completes the data from which to tabulate the annual net revenues for the next 30 or 40 years. This is preferably divided into two parts, one of which is the portion that applies to the plant as existing at present. The latter figures are determined by taking the earnings in proportion as the present plant cost is to the future total plant costs; that is, earnings applying to present plant for any year are to total earnings for that year as present cost is to total cost for that year. If money in the waterworks business is worth 8 per cent, he proceeds to reduce these future annual net revenues to present worth, and the sum will be a valuation from which should be deducted the accumulated depreciation up to the present time.*

The reason why the accumulated depreciation up to the present time must be deducted is that we are starting with a plant that has suffered a certain amount of depreciation. If this depreciation be figured from the beginning on a sinking-fund basis, at a fixed per cent on the cost, we cannot be justified in figuring it in the future at the same rate of per cent unless we place the accumulated depreciation up to the present time in a depreciation fund to the credit of the water company, or, what is exactly equivalent, to deduct that amount from the price of the plant, but the future depreciation must be figured on the plant cost the same as if no deduction had been made.

Table III shows a calculation for the market value of the property according to the method just described. At the present time the historical cost of the existing physical plant is assumed to be $204,399, or, in round figures, $204,000. The table shows the gross earnings in the future, both for the present plant and the necessary additions to it for capital account.

TABLE III.—VALUATION BASED ON "MARKET VALUE."

Year.	Estimated cost of plant at end of year.	Net returns = gross revenue less operating expenses and 1 per cent depreciation.	Net return on $204,000, original plant cost.	Present worth of these net returns on original plant cost at 8 per cent.
1917	$204,000	$20,730	$20,730	$19,180
1918	204,000	21,560	21,560	18,470
1919	207,300	22,390	22,030	17,490
1920	213,400	23,220	22,190	16,300
1921	219,500	24,050	22,350	15,220
1922	225,600	24,880	22,500	14,180
1923	231,700	25,710	22,640	13,220
1924	237,800	26,540	22,770	12,300
1925	243,900	27,370	22,890	11,450
1926	250,000	28,200	23,010	10,660
1927	256,100	29,030	23,130	9,920
1928	262,200	29,860	23,230	9,220
1929	268,300	30,690	23,330	8,580
1930	274,400	31,520	23,430	7,980
1931	280,500	32,350	23,530	7,420
1932	286,500	33,180	23,620	6,890
1933	292,700	34,010	23,700	6,410
1934	298,800	34,840	23,790	5,960
1935	304,900	35,670	23,860	5,530
1936	311,000	36,500	23,930	5,130
1937	317,100	37,330	24,010	4,770
1938	323,200	38,160	24,080	4,430
1939	329,300	38,990	24,150	4,110
1940	335,400	39,820	24,220	3,820
1941	341,500	40,650	24,280	3,545
1942	347,600	41,480	24,360	3,290
1943	353,700	42,310	24,420	3,060
1944	359,800	43,140	24,470	2,840
1945	365,900	43,970	24,520	2,630
1946	372,000	44,800	24,570	2,440
1947	378,100	45,630	24,620	2,265
1948	384,200	46,460	24,670	2,105
1949	390,300	47,290	24,720	1,950
1950	396,400	48,120	24,760	1,810
1951	402,500	48,950	24,810	1,680
1952	408,600	49,780	24,860	1,555
1953	414,700	50,610	24,900	1,440
1954	420,800	51,440	24,940	1,340
1955	426,900	52,270	24,990	1,240
1956	433,000	53,100	25,030	1,150
				$272,980
Less accrued depreciation				28,150
Required valuation				$244,830

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*It is interesting to note that the present worth of an annual net revenue for 40 and 30 years is about 95 and 90 per cent respectively of the same sum capitalized at 8 per cent.

Naturally, the valuator will make a critical examination of the territory, of the adequacy and public satisfaction of the water supply and service, have some of the pipes taken out to examine their condition, and make a careful inspection of the entire physical plant and its conditions, and from this inspection make such modification of his calculated value as his judgment indicates to be advisable.

While these three are the most important conditions for which valuations are required—and it has been shown that each requires a different viewpoint, different economic principles of appraisal, and leads to essentially different results—there are still other purposes of valuation, for which the methods to be pursued are not so obvious.

Suppose a water company desires to create a mortgage on its entire property or issue stock up to the warrantable limit of its valuation, upon what principle shall the valuation be derived? The usual case is where the water company must go before the public service commission for authority for such procedure, and said commission wishes to establish such a valuation as will protect alike the water company and those who may invest in its securities. It would seem that for this case the last method would be the logical one; that is, find the present worth of the estimated net revenue for the next 30 or 40 years, and from that deduct the accrued depreciation up to the present time.

The next important case is where it is desired to determine the valuation for the purposes of taxation. The common procedure for appraising properties for public taxation is to take the findings of an assessor elected for a term of years.

The law requires that the assessment shall be the true market value of each property. If a property holder thinks his property is assessed too high or too low, he has the right of appeal to the proper tribunal.

The function of the assessor is of great importance, and he should be a man of good experience and ability, but, as the salary is generally meagre and the method of election not such as to insure appointment of the best man for the place, the assessed values are often notoriously unjust. If the assessor happens to be honest and of good judgment, he endeavors to determine what each property would bring in the market if it were put up for public sale with reasonable publicity, and that is the figure he uses for his assessment. The case is not so difficult as it seems, because there are in his district hundreds of properties of nearly the same kind and many records of private and public sales. But for the case of a public utility, such as a water works, there is only one property like it, and there is usually no means of knowing what it would bring as a whole if put up at public sale. In some cases there may be records of sales of blocks of stocks or bonds, but even these are rarely sufficient to warrant a reliable conclusion as to the market value of the entire property, and therefore, in most cases, the only way to arrive at its market value is to determine the elements upon which market value must depend. Hence we are led by reason to the use of the third method of valuation.

In the court and commission rulings it is plain that they recognize various aspects of valuation, but apparently wish to establish such a valuation as will apply in all cases. So when the term "fair value" was read into one of the most classic of these cases the court evidently considered the matter settled for all time. But "fair value" changes every time the condition or purpose changes, and what applies in one case will not apply in another. So there is no logical justification in working out the valuation according to three fundamentally different principles, and taking some function of the three for the desired result, although that is apparently what the tribunal means when it substantially says: "Neither the cost of reproduction, the historical cost, nor the capitalized value of the net revenue can be taken as representing the desired valuation, but each has a material bearing and must be considered."

Subsidence of Muck and Peat Lands Subsequent to Drainage

It has long been a matter of common knowledge that swamp lands, which have soils containing a large percentage of vegetable matter, subside when drained and cultivated. In small districts drained by pumps this subsidence may not be a very important feature but in large gravity drainage districts with deep muck or peat, where slopes are slight and the available fall is small, subsidence may be of sufficient magnitude to make necessary a change in design. Valuable data on this question are contained in a paper* presented by Charles W. Okey, presented Nov. 7 before the American Society of Civil Engineers, from which the notes following are taken.

In the Fenland of England muck and peat lands have been drained and cultivated for a long period, with a consequent change in surface elevation. This change has been of such magnitude that it has made necessary the altering of a majority of the pumping plants that formerly gave adequate drainage to the lands they served.

In the Memoirs of the Geological Survey of England and Wales for 1877 there appears a volume written by S. B. J. Skertchly on the "Geology of the Fenland." Mr. Skertchly mentions the general sinking of the surface on all the cultivated and drained Fens, where there is muck or peat on the surface, and gives definite figures for several locations. In 1848, an iron column, graduated in feet and inches, was sunk down through the peat, in the Middle Level of the Great Bedford Level in the vicinity of Whittlesea Mere, into the solid clay, so that the top of the column was level with the surface. This column bears on the capital the inscription, "Level of the Ground in 1848." When Mr. Skertchly measured the subsidence of the surface on Aug. 25th, 1870, he found it to be 7 ft. 8 in. The subsidence was measured again in 1875 and found to be 7 ft. 9 in.

Richard F. Grantham states that in 1876 after erecting new engines and pumps, made necessary by the subsidence of the land, the total subsidence was then observed to be 8 ft. This was evidently after the new pumping plant had been put in, hence the drop of 3 in.

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*The Subsidence of Muck and Peat Soils in Southern Louisiana and Florida. Charles W. Okey. Proceedings American Society of Civil Engineers, Vol. XLIII, No. 7, pp. 1499-1522.

TABLE I.

Number.	Locality.	Dates.	Time, in years.	Thickness, in feet.	Total compression in inches.	Annual compression, in inches.	Total compression. Percentage.	Annual compression. Percentage.
1	East Fen	1806-66	60	6	24	0.4	33.3	0.55
2	Whittlesea Mere	1851-60	9	18	42	4.7	19.5	2.2
3	Whittlesea Mere	1851-60	9	18	59	6.6	27.3	3.0
4	Whittlesea Mere	1851-60	9	18	66	7.4	30.5	3.4
5	Whittlesea Mere	1851-60	9	18	73	8.1	33.8	3.7
6	Whittlesea Mere	1848-70	22	18	92	4.18	42.6	1.9
7	Whittlesea Mere	1848-75	27	18	93	3.44	43.0	1.59
8	Hilgay	....	26	10	52	5.2	43.3	1.7
9	Wood Fen	1851-74	20	8	37	1.85	38.5	1.9

in a year, due to the lowering of the water-table. In 1913 the total subsidence was observed by Mr. Grantham to be 10 ft. The peat at this point was originally 18 ft. thick.

Mr. Skertchly in his "Geology of the Fenland" also gives a table of the subsidence at this and other localities. This table is reproduced as Table 1.

In commenting on Table I, Mr. Skertchly states:

> The mean annual percentage of compression from the above data is 2.2, which under similar circumstances may be taken as the rate for a long series of years. By "similar circumstances" is meant low-lying peat in which very little fall can be obtained for the drains, for it is clear that if drains could be cut deep into or through the peat the compression would be more rapid.

Swamp soils which are largely of vegetable origin are classed as cumulose by the United States Bureau of Soils, with the subdivisions of peat, peaty muck, and muck. Peat is composed almost entirely of partly decomposed vegetable matter; muck has a considerable percentage of silt, clay and sand mixed with well-decayed and finely-divided vegetable matter. The different types merge into each other. Although it is not certain that all the soils considered in this paper would be properly classed as muck soils, the term will be used, because it will probably fit most of the cases and because it is in common usage in southern Louisiana and Florida.

The subsidence of such soils is due to three main causes: drying, decay, and cultivation. Shrinkage and the consequent subsidence, due to drying, affects most of the top layer, but it extends in a decreasing rate as deep as the soil is drained. Tests have shown that undrained Louisiana muck shrinks about 60 per cent in volume when completely dry, and that it will regain only 70 per cent of its original volume when saturated for a long time. Therefore, long-continued dry weather and deep drainage cause a shrinkage in the deeper layers of muck which is not counterbalanced by an increase in volume due to subsequent precipitation, or rising of the water-table. Only such part of the muck as is always saturated is entirely free from shrinkage due to drying.

The vegetable material in muck soils exists in a state of partial decay. In the undrained state it is saturated with water to such an extent that the process of decay is relatively slow. After drainage the air enters and decay is much more rapid. The warm, humid climate of southern Louisiana and Florida is very favorable to the rapid decay of vegetable material, much more so than in places where the surface is frozen for a part of the year. Like the effect of drying, that of decay is greatest in the top layer of material; but examination has shown that, after some years of drainage, the character of the muck at a depth of 2 ft. had been materially changed from its condition prior to drainage. Although the effect of decay is not as rapid in action as that due to drying, it is practically continuous. The complete decay of the vegetable material causes some loss of weight and a considerable loss in volume, thus gradually reducing the surface elevation of the muck.

As the effect of both the foregoing agencies is greatest in the top layer of the muck, the density of this top layer is gradually increased. After this comparatively dense material attains a thickness of a few inches, it prevents free circulation of the air into the muck below, and then drying and decay are much slower in their action. Muck soils which are so soft after drainage that they will not permit of the use of farm animals and machinery are compacted from 4 to 6 in. by the first plowing. This first plowing is usually done with some form of tractor, with broad wheels which cover practically all the surface plowed. Subsequently, when the muck is cultivated with farm animals and machinery, the surface receives unit pressures far greater than those exerted by the broad-wheeled tractor, and a further compacting results. The underlying material, which is turned to the surface by plowing, is exposed to a greater drying action than would otherwise result. Decay, also, is hastened in the material thus brought to the surface. It is the experience in cultivating newly-reclaimed muck soils that, for a number of years after the first cultivation, a uniform depth of plowing will bring to the surface each year a considerable layer of muck which was undisturbed by the previous year's plowing. This layer of new material gradually decreases in thickness, as the thickness of the layer of plowed material gradually increases. Finally, the cultivated layer attains such a density that the combined forces of drying, decay, and compacting reduce its thickness very little. If the land is not plowed deeper than this layer, the subsidence of the remaining muck is very slow; but, if the land is plowed deep enough to reach undisturbed muck, further subsidence results.

It is clearly evident that in planning drainage improvements for areas of deep muck land, some provision should be made for the gradual but certain decrease in elevation of the surface. In relatively small districts, where drainage is secured by pumps, this decrease can be met easily by lengthening the suction pipes on the pumps. As the drainage channels in such soft soils require considerable maintenance in the earlier years of drainage, they can be deepened accordingly. Where the land is drained by gravity, the elevation of the water at the outlet is usually fixed, and a change in elevation of the land to be drained will mean a revision of the hydraulic gradient in the main drainage channels, with the consequent change in width and depth of the channels.

Maximum Prices on Sheets, Etc.—The President has approved an agreement made by the War Industries Board with the principal steel industries of the United States fixing maximum prices, subject to revision Jan. 1, 1918, on certain steel articles, as follows:

Sheets (per 100 lb., f. o. b. Pittsburgh):	
No. 28 black sheets	$ 5.00
No. 10 blue annealed sheets	4.25
No. 28 galvanized sheets	6.25
The above prices to apply to both Bessemer and open-hearth grades.	
Pipe:	
On ¾-in. to 3-in. black steel pipe, discount 52 and 5 and 2½ per cent. f. o. b. Pittsburgh.	
Cold-rolled steel:	
17 per cent discount from March 15, 1915, list, f. o. b. Pittsburgh.	
Scrap (f. o. b. consuming point):	
No. 1 heavy melting, per gross ton	30.00
Cast-iron borings and machine-shop turnings, per gross ton	20.00
No. 1 railroad, wrought, per gross ton	35.00
Wire:	
Plain wire (per 100 lb., f. o. b. Pittsburgh)	3.25
Tin plate:	
Coke base, Bessemer and open hearth (per 100-lb. box, f. o. b. Pittsburgh)	7.75

In connection with the above, the iron and steel manufacturers have agreed promptly to adjust the maximum prices of all iron and steel products other than those on which prices have been agreed upon to the same general standard as those which have been announced. It is expected that this will be done promptly and consistently in line with the basic, intermediate and finished products for which definite maximum prices have been established.

Plans and specifications are underway for extensions to the Cedar River Water System of Seattle, Wash. The improvement will involve an expenditure of nearly $4,000,000.

State Control Over the Operation of Sewage Treatment Works

The 1917 report of the Committee on Sewage Works Operation and Analytical Methods, submitted Oct. 18 at the annual meeting of the American Public Health Association, deals entirely with the subject of state control over the operation of sewage treatment works. Extracts from the report follow:

The degree of control to be exercised by the State over the operation of sewage treatment works depends, of necessity, upon many conditions; generally, the degree of such control should vary inversely with the quality of maintenance provided by the municipality or other owner of the works and directly with the possible danger caused by falling off of efficiency in operation.

It is not a proper function of the State, excepting in cases of emergency, to do more than keep watch over the local authorities or to prod them to greater efforts. The ideal condition would be for each municipality or owner to so operate its sewage treatment works through its own agents—either trained employes constantly on the payroll or special consultants regularly engaged—that the work of the State would be resolved simply into the study and checking of the results accomplished by the works, but this ideal condition has not yet been obtained except in isolated instances.

The varying degrees of State control over operation of sewage works may be classified as follows:

1. No control at all.
2. Inspection on complaint, followed with general advice.
3. Routine inspection and advice wherever deemed advisable and necessary by the State Department.
4. Routine inspection as in No. 3 and also general supervision and control of operation.
5. Extension of duties outlined in Nos. 3 and 4 and authority to require the proper operation with adequate police powers to enforce the proper operation on the part of the municipality or owner and authority to require the maintenance of regular routine tests and records.
6. Actual operation of sewage treatment plants.

Considering these six classes of State control in connection with the 1916 report of the committee:

1. A condition of "no control" by the State of the pollution or contamination of its natural water resources by sewage is unworthy of further discussion. It was shown, however, in last year's report of the committee that 24 States, with a population in 1910 of over 24,000,000 people or 26 per cent of the total population of the United States, had no engineer on the staff of their Boards of Health or specific legislation over the disposal of sewage.

2. State control consisting in "inspection on complaint followed with general advice" is manifestly better than "no control at all." The principal danger in these cases is that, when improper or lax maintenance of sewage treatment works has progressed to such an extent that conditions arise which are made the subject of complaint by lay and nontechnical citizens, the trouble will be more difficult and expensive to remedy than had improper operation been discovered in its incipiency through regular inspection by a trained expert.

Such improper operation also may have resulted in the gross pollution of the source of water supply with resulting danger to the public health.

These conditions presumably could arise in the second group of States, cited in the 1916 report, in which the Boards of Health have an engineer or other officer charged with supervision over the disposal of sewage but whose legal powers are limited. There were nine such States having a population of less than 13,000,000 or 14 per cent of the total population in the United States.

3, 4 and 5. The powers expressed under these classifications are exercised to a more or less extent by the 15 States cited in last year's report. The population in these States in 1910 aggregated about 54,000,000 or 60 per cent of the whole population of the United States.

These three classifications vary progressively in degree of authority according to existing legislation and available funds.

The degrees of control set forth in Class 5 of:

Routine inspection, advice when deemed necessary, general supervision, adequate police powers to enforce proper operation, authority to require regular tests and records, in the opinion of the committee are most desirable and correspond to the recommendations of the report of last year.

6. The actual operation of sewage treatment works by the State Board of Health is not recommended. The proper operation of such works is as much the financial and physical responsibility of each municipality as control over its police or fire forces.

The desideratum in operation of sewage treatment works under State control may well be likened to the conditions existing in our national banks. The examiner checks the accounts and methods of business and, when found to be in accordance with law and the safety of the public, does not interfere; but if the bank is in an unsound condition the central governing power steps in and requires changes to safeguard the public, and, if the emergency is extreme, actually assumes temporary control.

In all the prior reports of the committee, it has been urged that owners or sewage works should employ competent and trained employes for operation, and the engagement of experts has been advised. For example, in the 1914 report it was stated:

> . . . Successful results are not always obtained unless the designing engineer or some competent person is called in at regular times to inspect and advise concerning the technical details of operation. . . . For the larger institutional plants and works for small towns more skilled attendants are required and the need for competent supervision is more urgent.

Again in the 1915 report it was stated:

> Municipalities frequently employ expert engineers to study local conditions and to design sewage treatment works, but when such works are put in service their operation is intrusted to an untrained employee. . . . This is a poor business policy; a municipality or private owner would not attempt to operate a power plant or other installation involving complicated machinery without the service of trained engineers because they know it would not be economical to do so.

And again in the 1916 report the same expression of need for employment of expert services was set forth, as follows:

> It is particularly important that early operation . . . should be intrusted to either the designer or some engineer familiar with the intricacies of operation.

But owners and municipalities are not always aware of these facts; they fail to recognize the need for expert advice and trained operators; therefore inefficient operation and in some cases nearly no operation result, hence the need for central control and authority.

Removal of Manganese from Water Supplies

In a thesis presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Illinois, Mr. H. P. Corson, of the Illinois Water Survey, outlines in a very interesting manner the methods developed for the removal of manganese from water supplies. In his thesis, which is printed in abstract below, he also describes two manganese removal plants now in operation in Illinois.

Three practical methods for the removal of manganese from water have been developed—aeration and filtration through sand, filtration through permutit, and filtration through pyrolusite. The problem of removing manganese has been attacked by most workers in a manner similar to that of removing iron. The usual method for the removal of iron from water is by aeration followed by filtration through sand, and it is generally and successfully used in many plants in the United States and Europe. Iron occurs in most ground waters in the ferrous condition. When the water is aerated the iron is oxidized to the ferric condition and separates as the hydroxide. This combination of oxidation, hydrolysis, and precipitation is the basic principle of the method though the presence of other substances somewhat affects the results. The occurrence of manganese with iron in many waters and its separation as the hydrated dioxide under certain conditions have led to the assumption that the element in water has chemical properties practically similar to those of iron.

Extensive experiments on removal of manganese by this method have been conducted by Thiesing, who worked with a water at Pomerensdorf, Germany. He has concluded that manganese occurring in water as the bicarbonate can be successfully removed by aeration and filtration. Trickling through beds of coke or spraying through nozzles were used as methods of aeration. The removal of carbon dioxide as well as solution of oxygen was found to be important in the process of aeration. Subsequent filtration through sand gave an effluent containing very little manganese; sedimentation effected little removal.

In this country extensive experiments along similar lines have been conducted by R. S. Weston with several waters containing iron and manganese in Massachusetts. Mr. Weston's problems have dealt chiefly with the removal of iron. A well water containing 0.73 part per 1,000,000 of iron and 0.23 part per 1,000,000 of manganese was treated at Cohasset by being sprayed through nozzles followed by passage through a coke trickling filter and mechanical filters. Satisfactory results were obtained in the experiments and arrangements have been made for construction of a large plant. In experiments at Brookline sprinkling through nozzles followed by passage through a coke trickling filter and slow sand filters decreased the content of iron from 0.6 to 0.2 part per 1,000,000. The content of manganese of the untreated water was 0.26 part per 1,000,000. Though Weston published no figures concerning the efficiency of the removal of manganese he stated that he found it roughly proportional to that of the removal of iron. A plant for removal of iron and manganese, which has been installed at Middleboro, treats 335,000 gal. a day of water. The water, after it has been sprayed over a coke trickling filter 10 ft. deep, flows into a settling basin and through slow sand filters operating at a rate of 10,000,000 gal. per acre per day. The content of iron was decreased from 1.5 to 0.2 part per 1,000,000 and the content of manganese from 0.67 to 0.27 part per 1,000,000 during the first run from Sept. 26, 1913, to Jan. 12, 1914. The efficiency of the removal of manganese increased as the plant was operated longer, and the effluent on Jan. 22 contained 0.10 part per 1,000,000 of manganese.

Barbour performed a similar series of experiments on the well-water supply of Lowell, Mass. The waters of the wells differ in content of manganese, the strongest containing 2.0 parts per 1,000,000. Aeration, sedimentation, and sand filtration were tried on an experimental scale. The efficiency of the plant was at first rather erratic, but it finally became possible to reduce the content of manganese to 0.01 part per 1,000,000. A dark coloration due to precipitated oxides of manganese was observed in the sand bed, and this extended in diminishing amounts to the bottom of the bed. On the basis of this study a plant was erected at a cost of $180,000 for the removal of manganese and iron.

Practically all students of removal of manganese by aeration and filtration have concluded that manganese is much more difficult to remove than iron. The details of the process, such as the amount of aeration and the rate of filtration, differ with the character of the water.

The permutit process for removal of manganese has come recently into the field. Manganese permutit consists of a zeolite with which a layer of manganese dioxide is incorporated. When a manganese-bearing water is filtered through this medium the manganese is removed from the water by the formation of a lower oxide of manganese by reaction between the manganese in the water and the manganese dioxide in the permutit. At the same time the alkali or alkaline-earth of the silicate is replaced by the manganous compound of the water. The replacement is of minor importance, and the slight extent to which it takes place is dependent on the concentration of manganese in the water. Manganese is added to the permutit not only when manganese permutit is regenerated by potassium permanganate, but also when manganese is removed from water by the regenerated permutit; therefore, the content of manganese dioxide increases and the filter medium approaches in composition pure manganese dioxide with each successive regeneration and reduction. As the zeolite can not increase in amount with successive reductions and regenerations the replacement effect must become less and less as the substance is used. These conclusions are in entire accord with that reached independently by Tillmans—that the action of manganese permutit is really the action of manganese dioxide.

Some preliminary experiments made by filtering an aerated artificially prepared manganese-bearing water through a small sand filter showed that no removal of manganese was affected. A mechanical filtration plant has been installed at Mount Vernon, Ill., however, for the purpose of removing manganese as well as effecting hygienic purification of a surface water, and analyses of the water some months after installation of the mechanical filters showed that manganese was being removed by this plant. Manganese is also removed in a filter plant at Anna, Ill., designed for hygienic purification of a surface-water supply. These results seemed contradictory to the negative results obtained on a small scale. Yet, as manganese dioxide had been used successfully for removal of manganese and as this compound is the basic part of manganese permutit it was concluded that manganese dioxide was the principal factor in the removal of manganese in successful sand filtration.

Two filters were, therefore, prepared for experimental use. The apparatus (see Fig. 1) consisted of two gas-washing cylinders (A, A) connected at their tops by a siphon to a large carboy (B) holding the water to be treated. The rate of filtration could be so adjusted by two stopcocks (S, S) that both filters would deliver their effluents at the same rate. A glass tube (C) extending to the bottom of the carboy provided means for admitting compressed air for aeration.

Each filter was filled with one liter of clean high-grade filter sand, having an effective size of 0.50 millimeter and a uniformity coefficient of 1.32. One filter was treated successively with solutions of manganous sulphate, sodium hydroxide, and potassium permanganate. After two or three treatments a thin film of black oxide of manganese had formed on the grains of sand. The filter was then washed with water until an effluent free from manganese was obtained. The other filter was used without such treatment. The apparatus consisted, therefore, of two filters working in parallel, one containing sand only, and the other containing sand which had been slightly coated with manganese dioxide. As the depth of sand in each was 35 centimeters, the filtering area of each was 28 square centimeters.

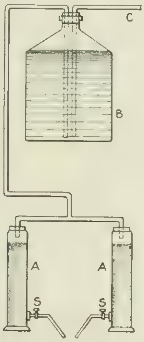

Fig. 1 — Experimental Sand Filters for Removal of Manganese.

The removal of manganese in a manganese-removal filter, depends on the contact of the manganous compound with manganese dioxide; consequently, the rate of filtration should be expressed in terms of volume of water filtered per volume of filter medium and not per area of filter surface. The rate varied slightly in these experiments, but it was so adjusted that a volume of water equal to the volume of the filter medium was filtered in twenty minutes.

Filtration through sand removed iron, but did not detectibly decrease manganese. The content of dissolved oxygen was decreased throughout more than one part per 1,000,000 by passage through the filters, even in the experiment in which no removal of manganese apparently took place. Filtration through sand coated with manganese dioxide removed all manganese and iron, decreased alkalinity 14 parts per 1,000,000, and decreased dissolved oxygen about the same extent to which it was decreased in the sand filter.

In order to determine the effect of adding a coagulant, 2 grains per gallon of alum was added, the water was then aerated, and allowed to settle one hour as in the other series. The results obtained indicate that little change is caused by addition of the coagulant. Complete removal of manganese was obtained by filtration through sand coated with manganese dioxide but practically no removal by filtration through sand alone.

The action in presence of both iron and manganese was studied by treating water in which 10 parts per 1,000,000 of manganese as $MnSO_4 4H_2O$ and 10 parts per 1,000,000 of iron as $FeSO_4 (NH_4)_2 SO_4 6H_2O$ had been dissolved. After this water had been aerated it had a high reddish-brown turbidity caused by precipitated ferric hydroxide. Treatment of this solution by filtration through sand alone resulted in complete removal of iron but no removal of manganese. Treatment of it by filtration through sand coated with manganese dioxide, however, completely removed manganese and iron. The alkalinity was not decreased by passage through either filter; this is not in accordance with the theory as the removal should have decreased the alkalinity by an amount equivalent to the manganese removed. This apparent discrepancy might be accounted for either by the presence of small amounts of substances capable of neutralizing free acid in the sand, or by oxidation of the manganous compound to a marked degree in the aeration and yet to a degree insufficient to form an insoluble compound.

Though no removal of manganese by filtration through sand could be detected by analysis the upper part of the sand became discolored by a slight deposit of manganese dioxide after the filter had been used for some time. This shows that there must have been some slight but continual removal of manganese by aeration and filtration. This slight deposit would rapidly aid in removal of more and more manganese until sufficient manganese dioxide would have been deposited to remove completely the manganese from water filtered through it; the process might be erroneously considered to be simply one of aeration and filtration through sand when in reality it is a catalysis by manganese dioxide.

Manganese-Removal Plants in Illinois.

Manganese is efficiently removed from surface-water supplies by filtration through sand coated with manganese dioxide at two plants in Illinois. One of these filter plants was installed for removal of manganese as well as for hygienic purification of the water, and the other was installed for hygienic purification only, the presence of manganese in the water not being suspected. There was evidence of unsatisfactory removal of manganese for some time after the installation of these plants, but efficient removal resulted after a period had elapsed for the deposition of sufficient manganese dioxide in the filters. As no similar observations have been reported a description of these two plants with some of the operating results are presented.

Removal of Manganese at Anna, Ill.—The water works of Anna State Hospital, in Southern Illinois, was put in operation in January, 1914. About half the supply is derived from a 2,000,000-gal. impound-

TABLE I—MINERAL ANALYSES OF THE WATER SUPPLY OF ANNA STATE HOSPITAL, OCTOBER, 1914.

(Parts per million.)

Ions—	Wilson Creek	Reservoir.
Potassium (K)	5.6	4.7
Sodium (Na)	17.8	11.8
Magnesium (Mg)	12.6	7.5
Calcium (Ca)	78.6	43.9
Iron (Fe)	1.0	0.6
Manganese (Mn)	Trace	1.4
Alumina (Al_2O_3)	1.2	3.0
Silica (SiO_2)	18.2	6.3
Nitrate (NO_3)	5.3	4.0
Chloride (Cl)	3.0	1.0
Sulfate (SO_4)	5.2	11.1
Hypothetical Combinations—		
Potassium nitrate (KNO_3)	8.6	6.5
Potassium chloride (KCl)	6.3	2.1
Potassium sulfate (K_2SO_4)	...	2.4
Sodium sulfate (Na_2SO_4)	7.7	14.5
Sodium carbonate (Na_2CO_3)	35.2	10.8
Magnesium carbonate ($MgCO_3$)	43.6	26.0
Calcium carbonate ($CaCO_3$)	196.2	109.8
Iron carbonate ($FeCO_3$)	2.0	1.2
Manganese carbonate ($MnCO_3$)	Trace	2.9
Alumina (Al_2O_3)	1.2	3.0
Silica (SiO_2)	18.2	6.3
Bases	2.0	0.0
Total	321.0	185.5

ing reservoir, on Kohler Creek, which receives part of the water from springs. The other half of the supply used is taken from Wilson Creek, a near-by stream.

Mineral analyses of these two sources of supply are given in Table I.

The supply from Wilson Creek contains practically no manganese, but that from the reservoir contains a large and variable amount. The content of manganese of water from the reservoir varies widely. Turbidity, color, and bacterial content are low compared with those of other surface waters of Illinois. The water contains much dissolved oxygen and very little carbon dioxide. Determinations showed 9.8 parts per 1,000,000 of dissolved oxygen, which is high, but only 3 parts per 1,000,000 of carbon dioxide when the temperature of the water was 20°C. The water is treated by ordinary mechanical filtration. About one grain per gallon of alum is added, after which the water passes through a sedimentation basin affording retention for 4 hours. Calcium hypochlorite is added at the outlet of the sedimentation basin at the rate of 0.2 part per 1,000,000 of available chlorine, after which the water passes to the filters. The nominal rate of filtration is 125,000,000 gal. per acre per day. The filters contain 9 in. of gravel and 30 in. of sand, which had, when it was put in place, an effective size of 0.55 millimeter and a uniformity coefficient of 1.43.

The presence of manganese in a surface water containing so much dissolved oxygen was not suspected until complaint was received that the filtered water was causing unsightly stains on white plumbing fixtures and was staining fabrics in the laundry a pale yellow. A content of 12 parts per 1,000,000 of manganese was found in the raw water July 22, 1914. Subsequent tests showed that the untreated water from the impounding reservoir contained 7.5 parts, July 30, and only 1.4 parts Oct. 5. The water of Wilson Creek contained 0.05 part July 30 and a trace Oct. 5. The effluent from the filters contained 0.05 part July 30 and 0.0 part Oct. 5. From December, 1914, to May 1915, determinations of manganese were made regularly in the laboratory of the water works. Manganese was detected in the filtered water in only 7 of 100 tests. The water applied to the filters during this period had a content of manganese of 0.0 to 1.0 part per 1,000,000; the removal is, therefore, very efficient.

The walls of the concrete filter units were covered with a layer of manganese dioxide, which in appearance resembled asphaltum paint.

The sand was black, although the incrustation was not sufficient greatly to increase the size of the grains. The incrustation was somewhat tenacious, but some of it became detached when the sand was stirred with water. The results of a soil analysis of the sand are given in Table II. Microscopic examination of the sediment washed from the sand grains as well as of the sediment from the water used in washing the filters showed the presence of diatons and algae, but no organisms resembling Crenothrix were found. The material consisted chiefly of debris, such as sand, clay, and precipitated hydroxides of manganese, iron and aluminum.

The presence of manganese dioxide in the incrustation on the filter sand is sufficient to account for the removal of the manganese from the water. To determine whether manganese dioxide was the only factor in the process, the two experimental filters, one containing sand and the other sand impregnated with manganese dioxide, which had been used in the former experimental work with artificially prepared waters, were used at Anna for filtering the raw water. The raw water contained 9.6 parts per 1,000,000 of dissolved oxygen and 3 parts per 1,000,000 of free carbon dioxide. Its temperature was 20°C. Complete removal of manganese was obtained when the filter taining sand alone was used. This filter, however, had been used for similar work previously, and a small amount of manganese dioxide that may have been present on the sand grains doubtless aided the removal.

In order to make the test more complete the raw water was filtered through another pair of filters, one containing some unused sand like that with which the larger filters at Anna are filled and the other containing sand from the filters which had been used nearly a year. The latter sand was coal black due to the coating of manganese dioxide which had formed on the grains. Complete removal of manganese was obtained with the used sand, and practically no removal was obtained with the unused sand.

The city of Dresden, Germany, has installed a manganese-removal plant, in which the water is filtered through a growth of manganese-depositing microorganisms that remove the manganese from the water. No microorganisms of this character were detected by microscopic examination of the filter sand and the sediment in the wash water from the plant at Anna. In order to test the possibility of their significance in the removal, however, some of the black sand which had been in use for several months and was removing the manganese was sterilized in the autoclave. A filter was prepared from this sterilized sand, and after it had been washed until it was free from manganese it was used to filter a solution of 5 parts per 1,000,000 of manganese as $MnSO_4 4H_2O$ in distilled water. Complete removal of manganese was obtained by filtration through the sterilized sand.

The results of these experiments prove conclusively that the deposit of manganese dioxide on the grains of sand effects the removal of manganese. The deposit, however, has been informed gradually by the slow deposition of manganese from the manganese-bearing water assisted by direct oxidation by the dissolved oxygen. The large amount of dissolved oxy-

TABLE II.—ANALYSIS OF FILTER SAND, ANNA STATE HOSPITAL.

Insoluble in hydrochloric acid	98.25
Soluble in hydrochloric acid	1.75
Loss on ignition	.91
The soluble portion consists of:	
Ferric oxide (Fe_2O_3)	16.8
Alumina (Al_2O_3)	26.5
Manganese dioxide (MnO_2)	12.0
Loss on ignition	54

TABLE III.—MINERAL ANALYSES OF THE WATER SUPPLY OF MOUNT VERNON.

(Parts per million.)

Ions	Casey Fork.	Reservoir.
Potassium (K)	7.6	8.3
Sodium (Na)	9.3	13.1
Magnesium (Mg)	10.0	17.6
Calcium (Ca)	13.2	23.3
Iron (Fe)	.1	1.6
Manganese (Mn)	Trace	1.15
Alumina (Al_2O_3)	2.0	1.0
Silica (SiO_2)	17.4	7.0
Nitrate (NO_3)	6.0	2.7
Chlorine (Cl)	3.0	5.0
Sulphate (SO_4)	62.1	130.8
Bases	5.4	3.8
Hypothetical Combinations—		
Potassium nitrate (KNO_3)	9.8	4.4
Potassium chloride (KCl)	6.3	10.5
Potassium sulphate (K_2SO_4)	.3	2.2
Sodium sulphate (Na_2SO_4)	28.7	40.0
Magnesium sulphate ($MgSO_4$)	19.4	87.0
Calcium sulphate ($CaSO_4$)	3.5	45.8
Calcium carbonate ($CaCO_3$)	30.5	24.5
Iron carbonate ($FeCO_3$)	.2	3.3
Manganese carbonate ($MnCO_3$)	Trace	2.3
Alumina (Al_2O_3)	2.0	1.0
Silica (SiO_2)	17.4	7.0
Bases	5.4	3.8
Total	154.1	231.8

gen always present in the raw water evidently oxidizes the lower oxide of manganese to the dioxide at the time the manganese is removed. The process is, therefore, catalytic and no regeneration is necessary. When the filter is washed the grains of sand are stirred up, and the friction probably is sufficient to scour off the coating of manganese dioxide sufficiently to prevent difficulty in operation of the plant.

Removal of Manganese at Mount Vernon.—At Mount Vernon, the water supply is obtained chiefly from an impounding reservoir fed by springs, but Casey Fork, a branch of Big Muddy River, furnishes an auxiliary supply. The mineral character of these two supplies is shown by the analyses in Table 3. Both supplies have a high percentage of saturation with dissolved oxygen. The water is treated with about one-half grain per gallon of alum. After sedimentation it is treated with calcium hypochlorite at the rate of 0.2 to 0.3 part per 1,000,000 of available chlorine. The concrete filters operate at a rate of 125,000,000 gal. per acre per day. The content of manganese in the untreated water varied from 0.05 to 0.8 part per 1,000,000. The content of manganese of the filtered water has ranged from 0.0 to 0.3 part per 1,000,000. No manganese was found in the filtered water on 35 of the 65 days on which tests were made.

The filter sand was coated with a dark colored substance, which contained a large amount of manganese (see Table IV). When the sand was examined microscopically before being washed no Crenothrix or similar organisms were found. The wash water contained clay, dirt, inert matter, diatoms, chlorophyl-bearing algae, debris, and similar material.

TABLE IV.—ANALYSIS OF FILTER SAND, MOUNT VERNON.

Insoluble in hydrochloric acid	99.01
Soluble in hydrochloric acid	.99
Loss on ignition	.43
The soluble portion consists of:	
Ferric oxide (Fe_2O_3)	4.8
Alumina (Al_2O_3)	27.7
Manganese dioxide (MnO_2)	35.0
Loss on ignition	43

The filter medium is similar to that used at Anna State Hospital. As the incrustation of the sand is not so great its content of manganese dioxide is somewhat smaller. This fact probably explains the somewhat lower efficiency of removal at Mount Vernon compared with that obtained at Anna State Hospital. The removal is effected, however, in exactly the same process as at the hospital, namely, by filtration through sand coated with a layer of manganese dioxide, which effects the removal.

The government has sent out to 500 long leaf pine mills notice of an embargo on all timbers over 2 in. thick and 10 in. wide, any length. All timbers over these dimensions must be reserved for shipbuilding, unless it is shown that they are needed for other purposes of paramount importance, when the embargo will be released, on application.

Creosoted Wood Stave Pipe

Some interesting features of the cresoting of wood stave pipe are described by Mr. O. P. M. Goss in the September, 1917, Proceedings of the American Society of Civil Engineers, in his discussion of a paper on Modern Practice in Wood Stave Pipe Design. An abstract of the discussion follows:

Untreated wood stave pipe has demonstrated its value when used with a thorough knowledge of the underlying principle controlling the efficient use of wood. There is in store for such pipe, however, a development which is now making its appearance and will materially change present practice, and that is the creosoting of the staves under pressure as a means of eliminating decay.

Considerable effort has been made by the Engineering Department of the West Coast Lumbermen's Association, particularly during the last 3 years, to improve the methods of creosoting Douglas fir in its various forms. One of the forms already studied is staves. In the methods of treatment which have been applied in the past (the old boiling or steaming processes), previous to the recent developments in the art of creosoting Douglas fir, there has been considerable loss in strength in compression perpendicular to the grain, due to the creosote treatment. This loss, of course, was not desirable in the case of staves, which depend on the strength of the wood in side bearing to resist the water pressure. There was a loss in strength of 30 per cent or more in the staves as a result of either of these treatments. However, by the process now in use—the "boiling under a vacuum method"—which greatly reduces the temperature of the oil during treatment, or simply treating under low temperatures, there has been no loss in the strength of the staves.

The West Coast Lumbermen's Association recently completed some strength tests on staves which had been creosoted by this mild-temperature method of treatment. Twelve Douglas fir staves were selected, which were entirely free from sap wood, and twelve other staves were chosen as nearly like the first group as possible, except that they contained various quantities of sap wood. All these staves were 6 ft. long, and were kiln-dried. A section 1 ft. long was cut off the end of each stave and retained for a control test. The remaining portions of each of the 24 staves were treated in the following manner:

They were warmed in creosote oil for 4 hours at 170° F., and pressed from 0 to approximately 100 lb. per square inch, until they had received about 16 lb. of oil per cubic foot.

The oil was then heated from 170 to 230° F. in 3 hours, and held at this latter temperature for 1 hour. The staves were then removed.

The final heating bath was for the purpose of removing the surplus oil and cleaning the stave.

After this treatment, the staves were free from excess of oil and easy to handle. They were then placed

TABLE I.—BAND BEARING TEST ON DOUGLAS FIR STAVES, NATURAL AND CREOSOTED. STAVES SOAKED IN WATER ONE MONTH BEFORE TEST.

Condition of stave.	Load, in pounds, required to press a section, 3.35 in. long, of bands of various diameter, into the stave to a bearing of 60° and 90° of arc. 0.193 in. diameter. 60°	0.193 in. diameter. 90°	0.226 in. diameter. 60°	0.226 in. diameter. 90°	0.497 in. diameter. 60°	0.497 in. diameter. 90°	0.625 in. diameter. 60°	0.625 in. diameter. 90°	Average for all tests.
Staves Containing Sapwood—									
Natural	166	371	218	453	507	1,046	608	1,334	594
Treated	171	414	250	518	620	1,338	756	1,663	716
Treated, in percentage of natural	103.1	111.6	114.7	114.4	122.3	122.1	124.4	124.7	120.5
Staves All Heartwood—									
Natural	196	460	267	574	592	1,291	714	1,572	708
Treated	210	531	332	713	752	1,596	880	1,929	868
Treated, in percentage of natural	107.1	115.5	124.4	124.2	127.0	123.6	123.2	122.7	122.6

in a water tank with the untreated pieces, and all were soaked for about 30 days. Then both the natural and creosoted staves were subjected to a band pressure test. In making this test, four sizes of bands were used, as shown in Table I. Each band was 3.35 in. long, and was pressed into the stave, for the entire length of the band, in a direction perpendicular to the grain of the wood, until it was embedded over an area equal to 60 and 90° of the arc. The loads required to cause this depth of compression are shown in Table I. Each stave, natural and treated, was subjected to tests with bands of each size. The results show clearly that creosoted staves of all heartwood as well as those of mixed heartwood and sap wood have strength values even greater than those obtained from the test of natural wood. The results are particularly significant, as the test approaches about as closely as possible the actual condition of staves in a pipe line in service. The creosoted staves uniformly show a slightly higher strength than the untreated staves tested under the same conditions. These results demonstrate clearly the fact that it is possible to creosote Douglas fir staves and retain all their original strength. They also indicate clearly the practicability of permitting sap wood in staves which are to be creosoted. In the staves tested, the penetration of the creosote oil in the sap wood was very complete in every case.

Recent experimental work conducted by Mr. Goss has also shown the practicability of perforating the outer surface of Douglas fir staves with small holes systematically spaced. The resistance of the oil passing into the wood along the grain is practically nil compared to that found in forcing the oil in across the grain. The fine holes, through which the depth of penetration and the distribution of oil is controlled, are so small and spaced so regularly that they do not reduce the strength of the wood when tested in compression perpendicular to the grain. The result of these perforations is that the depth of penetration and the distribution of the oil can be thoroughly controlled —two very important factors in securing the greatest efficiency from creosoted timber.

The final cost of a creosoted stave pipe line in place will be approximately 20 per cent more than that of an untreated Douglas fir line, and about the same as that of an untreated redwood line. A number of large items remain constant, regardless of the cost of the staves. The steel bands, the excavation, the backfilling, engineering, overhead, transportation and other costs remain constant regardless of whether or not the staves are creosoted.

The Chicago, Milwaukee & St. Paul R. R. has awarded contracts amounting to nearly $2,000,000 for electrical equipment for its new electrified division. The equipment contracted for includes 17 electric locomotives at an average price of about $100,000 each and substation machinery for the 216-mile Othello-Seattle-Tacoma division. The orders were divided between the Westinghouse Electric & Manufacturing Co. and the General Electric Co.

Disinfection of Sewage by Copper Salts

Investigations are now being conducted by the city of New Haven, Conn., to determine upon a method of sewage disposal for the city. A sewage experiment station (described elsewhere in this issue) was placed in operation last spring. Mr. F. W. Mohlman, formerly chemist and bacteriologist of the Illinois Water Survey, was chemist and engineer in charge.

Four-ounce samples of raw sewage and effluents are collected every hour and combined into composites for chemical analysis. Samples are collected for bacterial analysis as often as time permits. On May 7-8, 24 samples were collected, one each hour, and a complete analysis made of each sample (Table 1).

These results indicate that some trade-waste containing large amounts of chlorides is discharged into the sewer from 7 a. m. to 6 p. m. The nitrogen determinations show that the sewage is very fresh, the ratio $\frac{\text{Ammonia nitrogen}}{\text{Total organic N}}$ being unusually low. The presence of large amounts of nitrite and nitrite nitrogen also testifies to the freshness of the sewage. The alkalinity, oxygen consumed, and suspended solids are unusually low. The dilute character of the sewage is due largely to the high consumption of water in New Haven, amounting approximately to 180 gal. per capita per day.

TABLE I—ANALYSES OF SAMPLES OF RAW SEWAGE COLLECTED HOURLY, MAY 7-8, 1917.

Time.	Chlorine.	Alkalinity.	Ammonia N.	Total organic N.	Nitrite nitrate N.	Oxygen consumed.	Suspended solids.	Total solids	Bacteria, 20 C.	Gas formers, 37° C.
8 a. m.	2,075	76	10.4	17.6	3.8	50	165	4,430	4,200	100
9 a. m.	2,750	94	7.6	14.0	2.6	49	415	6,178	......	......
10 a. m.	2,725	70	6.0	11.0	2.4	50	230	5,880	4,500	100
11 a. m.	2,875	90	4.0	13.6	2.4	50	122	5,057	......	......
12 a. m.	2,775	104	4.2	12.6	2.5	51	133	5,872	70,000	1,000
1 p. m.	2,675	98	4.0	13.6	2.2	50	189	5,440	......	......
2 p. m.	2,675	66	3.4	11.0	2.5	45	155	4,313	97,000	1,000
3 p. m.	2,100	72	3.2	10.4	3.2	51	107	5,583	......	......
4 p. m.	1,600	80	3.6	10.8	3.8	42	87	3,325	33,000	1,000
5 p. m.	1,350	48	3.4	11.0	3.2	37	97	2,840	......	......
6 p. m.	100	56	4.8	12.8	2.4	48	126	540	25,000	1,000
7 p. m.	47	108	4.2	13.4	1.4	52	90	433	......	......
8 p. m.	38	72	4.6	15.4	1.3	50	97	342	......	......
9 p. m.	36	80	5.8	10.2	1.2	49	80	312	......	......
10 p. m.	37	72	5.4	9.0	1.6	35	65	262	......	10,000
11 p. m.	32	70	5.6	9.4	1.1	33	47	230	......	......
12 p. m.	29	64	4.8	7.2	1.0	22	42	170	......	10,000
1 a. m.	23	56	3.2	5.6	1.1	15	21	108	......	......
2 a. m.	21	48	2.0	5.2	1.0	14	18	115	......	1,000
3 a. m.	17	46	1.8	3.0	1.3	15	9	93	......	......
4 a. m.	14	42	1.6	2.4	1.2	9	14	92	150,000	10,000
5 a. m.	17	42	2.0	3.6	1.4	15	17	122	......	......
6 a. m.	20	56	3.6	10.0	1.3	24	42	182	51,000	100,000
7 a. m.	1,350	68	5.4	17.0	1.2	34	87	2,655	362,000	10,000
Average	1,058	70	4.4	10.4	2.0	37	104	2,275	88,500	12,100

The most unusual features of the analyses are the large amounts of chlorides and total solids, and the low bacterial content during the daytime. During the week of July 9-16, samples collected at the plant during the daytime had the following bacterial content (Table II).

TABLE II—BATERIAL CONTENT OF SEWAGE, WEEK JULY 9-16.

	Total count, Agar, 20 C.				Gas formers, 37° C.			
Day.	8 a. m.	10 a. m.	1 p. m.	4 p. m.	8 a. m.	10 a. m.	1 p. m.	4 p. m.
Monday	1,500,000	225,000	59,000	16,000	100,000	1,000	1,000	100
Tuesday	1,080,000	128,000	5,000	7,500	100,000	100	1,000	100
Wednesday	1,670,000	81,000	7,000	100,000	100,000	100	100	1,000
Thursday	1,100,000	148,000	1,500	12,000	100,000	10,000	100	10
Friday	1,125,000	42,000	9,000	9,000	100,000	100	100	100
Saturday	......	68,500	7,100	*800,000	......	100	10	*100,000
Average	1,295,000	115,400	14,700	159,000	100,000	1,900	385	17,000
Sunday	......	3,355,000	2,275,000	2,535,000	......	100,000	100,000	100,000

*Factories shut down at noon Saturday.

The results clearly show the presence of some disinfecting substance in the weekday sewage. Although the sewage was found to be acid at times, the composite samples are never acid, and it is believed that none of the above samples for bacterial analysis were acid.

The ignited residue from the mat of suspended solids deposited in a Gooch crucible was usually of a brilliant red color, quite similar to the residue of cuprous oxide obtained in the determination of reducing sugars with Fehling's solution. Qualitative tests of the mat for copper were positive. This led to the conclusion that the disinfection of the sewage is due to copper salts.

The bactericidal action of the copper ion is well known. Copper sulphate was first proposed as a disinfectant for water and sewage by B. Krohnke in 1892. It was first used in America by Moore and Kellerman in 1903. Extensive studies were made by Johnson and Copeland in 1904 at the Columbus Testing Station on the use of copper sulphate as a disinfecant for sewage. They obtained the results shown in Table III by treating Columbus sewage with copper sulphate.

These data indicate that 5.0 parts per 1,000,000 of copper in solution in sewage are sufficient to exert a marked disinfecting action. Quantities as low as 2.5 parts per 1,000,000 were almost as effective as 5.0 parts per 1,000,000 when treating the effluents from a contact bed.

In order to find the source of the copper and the high chlorides in New Haven sewage, samples were collected from manholes at various places in the sewer, from the source to the outfall (Table IV).

TABLE III—EFFECT OF COPPER SULPHATE ON BATERIA IN COLUMBUS SEWAGE—JOHNSON AND COPELAND, 1904.

Organic nitrogen, 6.3 parts per million.
Composition of sewage alkalinity, 376 parts per million.
Bacteria, 1,200,000 per cubic centimeter.

Copper sulphate Cu, p.p.m.	Total count, gelatine, 20° C. Hours of contact 0	1	6	24
0	1,200,000	1,200,000	6,000,000	14,000,000
5	1,200,000	14,000	700	3,100,000
2.	1,200,000	9,500	250	200
250	1,200,000	2,000	190	35

TABLE IV—SOURCE OF COPPER AND CHLORIDES IN NEW HAVEN SEWAGE.

Alkalinity, chlorine and copper in parts per million.

Sample.	Description	Alkalinity.	Chlorine.	Copper.	Bacteria per c.c., 20° C.	Gas formers per c.c., 37° C.
1.	Near source of sewer...	54	67	0.0	990,000	100,000
2.	Below munitions factory.	90	144	8.8	3,000	100
3.	Below munitions factory.	165	74	5.6	3,000	1,000
4.	Small branch sewer.....	134	72	0.0	559,000	10,000
5	Main sewer	..	..	...	70,000	100
6.	Main sewer	156	71	1.9	380,000	10,000
7.	Below rubber factory...	90	2,700	3.5	65,000	1,000
8.	Experiment Station	130	2,500	...	53,000	1,000

TABLE V.—DISINFECTION OF SEWAGE BY COPPER, AUGUST 10, 1917.

Time.	Chlorine.	Alkalinity.	[illegible]on.	Copper.	Hours, undiluted.	Methylene blue, 1 sewage, 2 water.	Count, 20° C.	Gas formers, 37° C.
6 a. m....	30	94	.1	.56	6	120	3,700,000	100,000
7 a. m....	3750	136	.2	1.52	6	24	....	....
8 a. m....	3100	160	5.0	1.36	24	72	2,500,000	1,000,000
9 a. m....	2900	101	1.8	2.88	48	120	....	....
10 a. m....	2800	43	.3	4.80	168	192	19,000	100
11 a. m....	2750	114	.4	2.72	60	144	....	....
12 m.......	2800	98	.2	4.00	144	168	559,000	1,000
1 p. m....	3075	6	5.5	5.60	240	240	....	....
2 p. m....	3200	86	.6	1.92	24	72	187,000	10,000
3 p. m....	3325	91	.7	1.60	24	120	....	....
4 p. m....	3375	88	.2	1.92	48	96	39,000	100
5 p. m....	3450	98	.1	3.52	150	144	....	....
6 p. m....	130	103	.4	2.88	216	100	45,000	1,000
7 p. m....	95	63	1.4	1.28	72	80	....	....
8 p. m....	72	92	.2	.64	24	96	33,000	1,000
9 p. m....	50	96	.0	.44	6	24	....	....

Copper was determined by evaporating the sample to dryness with 2 c.c. of concentrated nitric acid, taking up the residue in distilled water, filtering, and adding 2 c.c. of concentrated sulphuric acid. This solution was electrolyzed between platinum electrodes for three hours at 70° C., using three dry cells as a source of current. Experiment showed that all the copper was deposited in this time. The cathode was removed, the copper dissolved in nitric acid, the acid driven off on the steam bath, and the residue dissolved in distilled water. An aliquot portion of this solution was diluted to 50 c.c. in a Nessler tube, and 10 c.c. of alkaline sodium sulphide added. The color developed was compared with that produced by a copper sulphate solution containing .2 milligram of copper c.c., when treated with 10 c.c. of the alkaline sodium sulphide. This method is similar to that in Standard Methods of Water Analysis with a few changes.

The entrance of the high chlorides is clearly shown to be between samples 6 and 7. Inquiry showed that a large rubber factory in this vicinity was pumping 2,000 gal. of sea-water per minute for condenser purposes, all of which was discharged into the sewer.

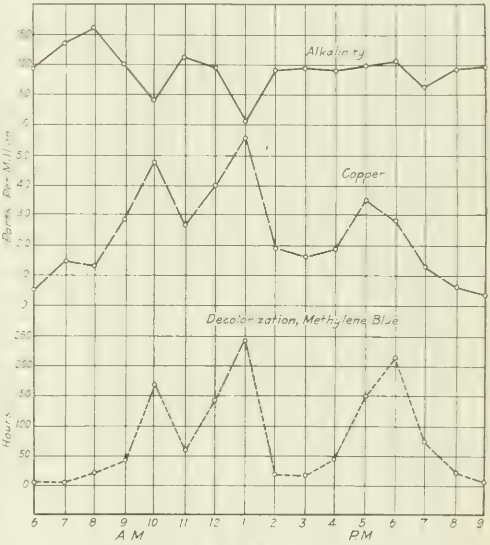

Fig. 1.

Between the places where samples 1 and 2 were collected there is a large munitions factory which employs 15,000 people. This factory manufactures brass cartridges and cannon shells. In stamping out these shells the brass must be annealed several times, and after each annealing the scale must be removed. The shells are washed with hot water and dilute sulphuric acid after each annealing, 1,600 lb. of acid and 120,000 gal. of water being used per day for this purpose. The waste goes into catch basins, in which some of the solid particles are removed, but the residual acid wastes, containing copper and zinc sulphates, goes into the sewer. Here the acid is neutralized by the bicarbonates in the sewage, and the copper sulphate is changed to the basic carbonate:

$$2\ CuSO_4 + 2\ Ca(HCO_3)_2 = CuCO_3.Cu(OH)_2 + 2CaSO_4 + 3CO_2 + H_2O$$

This basic carbonate is gradually changed to the hydroxide:

$$CuCO_3.Cu(OH)_2 + H_2O = 2Cu(OH)_2 + CO_2$$

Ellms has shown that the presence of carbon dioxide and organic matter greatly retards the precipitation. He found that quantities as great as 5 parts per 1,000,000 of copper may be retained in solution by organic matter for long periods of time. Since the sewage from the munitions factory reaches the Experiment Station in approximately one hour, it is probable that most of the copper is still in solution. Its germicidal power is increased by the high temperature of the sewage, averaging 84° F. during August.

There is a noticeable correlation between the number of bacteria and the amount of copper, as shown in Table III. In order to determine whether the disinfecting action is greatest at the time when the copper content is greatest, samples were collected at the Experiment Station from 6 a. m. to 9 p. m. on Aug. 10. Four-ounce samples were incubated at 20° C. with methylene blue, the time required for discoloraization being a rough measure of the strength of the disinfecting action. Diluted samples were also incubated, and bacterial counts made (Table 5 and Fig. 1).

The time of decolorization varies directly, the alkalinity and bacterial content vary inversely, with the amount of copper. The physical appearance and tests showed markedly the effect of the copper. The samples collected at 6 a. m., 8 p. m., and 9 p. m. became septic within a few days, developed a strong odor and lost their colloidal appearance. The remaining samples, with the exception of the one collected at 1 p. m., retained their original odor, that of fresh sewage, and remained colloidal and opalescent. The relatively high iron content of the 1 o'clock sample produced a floc of iron hydroxide which coagulated the suspended matter and clarified the sewage. The results obtained by incubating samples show that in some cases, notably at 5 and 6 p. m., the diluted samples were discolorized before the undiluted ones. This shows how impossible it is to apply the "dilution method" for the determination of the oxygen demand of this sewage. By incubating the composite sample of raw sewage with methylene blue, however, it is possible to obtain a rough measure of the amount of germicide present. The Sunday sewage will reduce the methylene blue to the leuco-base within 6 hours; some week-day composites have not produced the colorless compound for more than 20 days.

The effect of the copper on the various processes being studied remains to be seen, since operation has not been continued sufficiently long to allow any conclusions to be drawn. The company producing the copper-bearing wastes has investigated the recovery of the copper and acid, and claims that such recovery would not be profitable because of the great concentration necessary. If the wastes interfere seriously with the solution of the sewage disposal problem, their removal will probably be considered again.

New York Contractor Secures $10,000,000 Contract. —James Stewart & Co., Inc., New York City have been awarded contracts calling for over $10,000,000 worth of construction work in connection with the government's war preparations on Hampton Roads, Norfolk, Va.

$2,800,000 to Be Expended by Toledo, O., for Sewerage Improvements

The citizens of Toledo, O., on Nov. 6, authorized a $2,800,000 bond issue for the construction of intercepting sewers and sewage disposal plants to eliminate pollution of Swan and Ten Mile Creeks. The plan calls for the construction of four intercepting sewers: Ten Mile Creek sewer, West Side and Swan Creek sewer, West Side branch sewer and East Side sewer. These interceptors are designed to receive the discharge of each of the city sewers now built and also to receive the sewage from county sewers now built or planned, draining areas adjacent to Toledo and which will be part of Toledo within the next 40 or 50 years. These county districts are allowed by the State Board of Health to build separate sewers with the distinct understanding that they shall be connected to the city intercepting sewers as soon as they are built. County districts making connections to city intercepting sewers will pay their proportionate share of the cost of the city intercepting sewers when they make such connections.

The proposed system of intercepting sewers is planned so that the villages of Maumee, Perrysburg, Rossford, Point Place, and intervening territory, may drain by gravity into them. It is contemplated that the Ohio State Board of Health will eventually require these communities to purchase entrance into Toledo's sewers in order to protect Toledo's water supply.

There will be two pumping stations. One, located on a small island in the Maumee River off Bay View Park, is designed to pump all the sewage originating on the west side of the river. The sewage comes to this station at an elevation about 25 ft. below the surface of the river, and must be pumped across the river and into the proposed sewage disposal plant. The other pumping station, to be located on the other side of the Maumee River, near the lower Terminal R. R. bridge, will raise the sewage originating on the east side to the disposal plant.

The sewage disposal plant is to be located on a point of land between Duck Creek, Maumee River; and the Craig Oil Refinery. It will consist of Dortmund settling tanks, sludge digestion tanks, and sludge drying beds. The clarified effluent will then be discharged through submerged outlets into deep water in the river.

The estimated cost of the work, based on prices of labor, material and apparatus in Toledo, for the month of July, 1917, is as follows:

Ten Mile Creek Intercepting Sewer	$501,300
West Side and Swan Creek Intercepting Sewer	739,800
West Side Branch Intercepting Sewer	86,950
East Side Intercepting Sewer	311,300
River Crossing at Bay View Park	57,200
Bay View Park Sewage Pumping Station	107,300
East Side Sewage Pumping Station	69,700
Sewage Disposal Plant	612,210
Total estimated cost of entire project	$2,485,760
Engineering and contingencies, 10%	248,600

The first work will be done on the Ten Mile Creek interception and the Bay View Park pumping plant, and legislation for these jobs will be proceeded with at once. This work includes 6 miles of sewer from 48-in. to 72-in. in size, several interceptors and two siphons. About half of this sewer will be in open-cut and about 3 miles of 72-in. will be in tunnel. The pumping plant will be an attractive, substantial building of the size that will ultimately accommodate 50,000,000-gal. pumps. Motor-driven centrifugal pumps of a smaller size will be installed at this time. The bond legislation will take about 60 days, so that this work will not come up for actual figures before Feb. 1.

Watson Harmon is City Sanitary Engineer and Harry C. McClure is Commissioner of Engineering and Construction.

Reclamation of Alkaline Lands

While under drainage is the basis of the reclamation of alkali or silt lands, drainage alone often is ineffective for complete reclamation and subsequent treatment is necessary. The salt content not only must be reduced to a safe percentage, but it may be found that the presence of the salts has injured the physical texture of the soil and perhaps destroyed the humus content. Humus must be restored, evaporation must be reduced so that the future rise of salts may be prevented, and the tilth of the soil must be improved. The methods for accomplishing these results are outlined as follows in a recently issued Farmers' Bulletin prepared by R. A. Hart, Senior Drainage Engineer of the U. S. Office of Public Roads and Rural Engineering:

If expedition be desired in the removal of salts, or if natural precipitation and irrigation are insufficient to effect a satisfactory reduction in the percentage, a good-sized stream of irrigation water should be turned on the land and allowed to percolate through the soil as rapidly as possible. This is best accomplished by diking the land into checks and ponding the water as deeply as feasible, each check having as large an area as the slope of the ground and the amount of available water will permit. In no case should an attempt be made to flush the salts from the surface. They must be leached out and carried downward in solution to the underground reservoir. The desirability of using large checks and liberal quantities of water is due to the fact that capillary attraction is equally effective in all directions, and it is necessary to offset the tendency of the salts to move laterally in the soil and reappear on a higher or dryer portion of the tract. For this reason it is required to make sure, in flooding, that all the surface is covered, even if knolls and ridges must be leveled first. It is advisable generally to cultivate a field thoroughly before the leaching process, but in some cases it has been found to be more satisfactory to flood first and then cultivate as soon afterward as possible. If the subsoil be so impervious that the leaching water does not percolate readily, it may be necessary to resort to subsoiling or blasting.

The following actual example of reclamation is offered to demonstrate the principles that have been stated:

Before drainage the ground water on a certain tract stood within 2 ft. of the surface, which was covered with a white crust of alkali salts. Nothing of value grew on the tract, the only vegetation being an occasional salt weed. The average salt content for the first 4 ft. of depth was 2.25 per cent of the soil. A drainage system was installed and in a month's time the excess water in the soil had run out, so that the ground water table was practically down to the level of the drains. This excess water contained a great deal of salt in solution, so that analyses made at the end of the month showed that the average salt content for the 4 ft. had been reduced to approximately 1 per cent. The ground surface was cultivated and irrigated with a limited supply of water and some crops were planted, but gave only fair results. Meanwhile the higher temperature off summer has increased the evaporation and it was found that the average salt content for the 4 ft. increased to 1.28 per cent in spite of the drainage. A nearby uncultivated and unirrigated spot which had been affected to some extent by the drainage system showed an average salt content for the first 4 ft. of 1.51 per cent. It was evident that drainage alone would never reclaim the tract, so a heavy flooding was given it with the result that the average salt content for the first 4 ft. was reduced to 0.43 per cent, which is less than one-fifth of the original content. At this time the nearby uncultivated spot showed an average salt content for the first 4 ft. of 1.73 per cent, an increase which was due to the flooding of adjacent land while the spot itself remained dry. Further irrigation of the drained tract will reduce the salt content on the tract and increase that on the uncultivated spot.

Land should be cropped as soon as possible after reclamation; some crop which will shade the ground is preferable. If possible, the plans should be more or less alkali resistant. It must be kept in mind that the harmful salts are brought to the surface of the ground in solution by the capillary action of the soil and that they are deposited upon the surface when the solution is evaporated; hence the advisability of planting shading crops which reduce the evaporation. Artificial or soil mulches accomplish the same thin, and if shading crops are not planted, the soil should be kept well stirred. Subsoiling, in addition to assisting the leaching water to percolate to the drains, breaks up the capillary columns and retards the upward movement of salts.

Copious amounts of water should be used in irrigation and the water should be spread at once over as large areas as possible, making sure that the ground is covered as uniformly as may be. Waste water should not be allowed to run off the tract, as it is only the water that percolates downward that removes an appreciable amount of salt. However, water should not be allowed to pond in depressions or elsewhere for any considerable time after the head is turned off. If there is a tendency for the water to pond in this manner, either the depressions should be leveled up or surface inlets to the drain lines be provided, so that the excess may be removed in a short time.

Candidates for Officers of New England Water Works Association for 1918.—The nominating committee of the New England Water Works Association has named the following candidates for office for 1918: President, Carleton E. Davis, chief, Bureau of Water, Philadelphia, Pa.; Vice-Presidents—Samuel E. Killam, superintendent pipe lines and reservoirs, Metropolitan Water District, Boston, Mass.; Henry V. Macksey, superintendent of public works, Woburn, Mass.; Frank A. Barbour, consulting hydraulic and sanitary engineer, Boston; Percy R. Sanders, superintendent of water works, Concord, N. H.; Thomas McKenzie, superintendent water works, Westerly, R. I., and Henry R. Buck, consulting engineer, Hartford, Conn; Secretary, Willard Kent, civil engineer, Narragansett Pier, R. I.; Editor, Henry A. Symonds, hydraulic engineer, Boston; Executive Committee—Frank J. Gifford, superintendent of water works, Dedham, Mass,; A. R. Hathaway, water registrar, Springfield, Mass., and H. T. Sparks, superintendent of water works, Brewer, Me.; Finance Committee—George A. Carpenter, city engineer, Pawtucket, R. I.; Edwin L. Pride, public accountant, Boston; Bertram Brewer, superintendent sewers and water works, Waltham, Mass.

Synchronous Motors Drive City Water Pumps

Water-pumping, on account of its high load-factor, is a load which many central stations have found profitable. One of the more recent installations of this character is that supplied by the Camden Iron Works for the Del Air plant of the Camden, N. J., water-supply system. This consists of two pumps having a total capacity of 10,000,000 gal. per 24 hours.

A brick building houses the apparatus which is placed about 12 ft. below ground level. There are two 12 in. centrifugal pumps, double-suction, single stage, each connected with a horizontal shaft to a 200 h.p. Westinghouse synchronous motor. There are also two rotary vacuum pumps each connected to a 10 h.p. Westinghouse induction motor.

Power for this station is received from lines of the Public Service Company at 2,200 volts, and used in the main pump motors at this voltage. Transformers are provided to serve the vacuum pumps at 220 volts and for lighting purposes.

The switchboard has three panels—one for each main pump motor, carrying the necessary relays and switches, and an ammeter and reactive factor meter, and a metering panel carrying the central station's kilowat-hour meter and a curve-drawing wattmeter. The smaller pumps are controlled from switches near each one.

During a test run these pumps operated against a suction head of 27.33 ft. and 26.5 ft. respectively and a pressure head of 150 ft. In spite of the fact that the water contained some air, the high overall efficiency of about 72 per cent was achieved, involving consumption at the rate of about 160 kw.

It is readily possible by the use of the reactive-factor meters and regulation of the synchronous motor field to secure any power factor desired. This makes it possible to keep the station at unity power factor, or to supply leading current to improve conditions in the district. Since the pumps can be run at any time, it is often desirable to shut them down at the times of heaviest load on the central station.

All the electrical equipment in the new station was furnished by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

News Letter

St. Louis Items.

Dunn & McCarthy are increasing forces on their Pennsylvania work near Indianapolis, Ind.

W. A. Gierke has a small job of team work on the Burlington R. R. at Shattuc, Ill., to sublet.

J. W. McMurray Contracting Co. are finishing several jobs for the Katy in Southern Kansas and Oklahoma.

J. J. Connors came in from Chicago looking up a job for his 35-team outfit. 1246 Melrose street, Chicago, Ill., will catch him.

R. L. Cheshire has his big team outfit at work on a 260,000-yard levee job near Knowltons Landing, Ark. Expects to finish about the 1st of February.

Columbus S. Jones, the boss stationman, has finished his station work on the Rock Island R. R. near Geneseo, Ill., and moved his headquarters to Centreville, Ill.

Harrington Bros. have finished their work at Sesser, Ill., and are moving a part of their outfit on to the new reservoir job that they were recently awarded at Benton, Ill.

P. J. Murphy, Moberly, Mo., has a small team job on the Wabash R. R. near Hardin, Mo. Also a levee job that requires the moving of about 35,000 cu. yd. of earth near Wakenda, Mo., to sublet.

Stresenreuter-Cotton & Co., Dawson Springs, Ky., have about 21,000 cu. yd. of rock and earth work to sublet on the Illinois Central R. R. near that point. This job is suitable for a small revolving shovel and small cars.

P. H. Smith Construction Co., Caddao, Colo., are finishing their work at that point. Are in the market for some more work for their ten-team outfit. Are not particular whether it is in the United States or in France.

A. L. Cook, Ottawa, Kans., can use quite a number of team outfits on the M., K & T. R. R. in Southern Oklahoma. Also has some good station work to let on this line. Free transportation over the M., K & R. R. for labor and outfits.

McDonell Bros., 1101 Mason street, Flint, Mich., write us that they have two Keystone outfits idle at that point. Both machines are equipped for sewer work or grading. Will rent one or both machines with or without experienced operators.

L. H. Mummert of the Central Labor Bureau, Cincinnati, O., spent a couple of days with us here. Mummert reports that Cincinnati is getting to be a real live labor town and extends an invitation to all contractors when in that burg to call around at his office, 408 W. Fourth street, and get acquainted.

R. Sinclair of the Dupont Powder Co. reports the best business in history. Sinclair is a little in advance on distributing Christmas presents to contractors in the shape of an elegant briar pipe which is very much appreciated by those who are lucky enough to receive one. A. B. KOENIG.

Personals

O. H. Lang, Moultrie, Ga., has been appointed town engineer of Thomasville, Ga.

E. C. La Rue, hydraulic engineer, connected with the United States Geological Survey, has been transferred from Salt Lake to Pasadena, Cal.

Major Benedict Crowell, Engineer Corps, U. S. Army, heretofore in charge of the Washington office of the Panama Canal, has been appointed Assistant Secretary of War.

F. O. McGill, John Eddy, B. E. Cunningham and L. E. McKeeth have organized the Gem State Construction Co., of Nampa, Idaho, and will engage in a general contracting business.

Prof. George R. Dean, head of the department of mathematics at the School of Mines at Rolla, Mo., has been appointed consulting engineer of the General Electric Co. and commissioned to carry on a mathematical and experimental investigation of magnetism and magnetic properties.

Milton W. Franklin, formerly engineer of the ozonator department of the General Electric Co., has severed connections with that company to go with E. F. Houghton & Co. as consulting engineer. Dr. Franklin becomes a member of the board of directors and chairman of the sales committee and assumes charge of plants and equipment and manufacturing processes.

J. B. Marcellus, recently division engineer, Portland Cement Association, Kansas City, Mo., has been appointed state drainage and irrigation engineer of Kansas. Mr. Marcellus is a graduate of Kansas State University Engineering School, and has had 15 years' practical engineering experience, including drainage and irrigation in the West and Northwest. His office is at Manhattan in connection with the extension division of the State Agricultural College.

Allen T. Russell has been elected city surveyor of Baltimore, Md. Mr. Russell at one time was county surveyor of Du Page County, Illinois, and later was city engineer of Wheaton, Ill. He located and constructed the Aurora, Elgin & Chicago R. R. He resigned this position to become chief engineer and general manager of the Bluffton & Chicago R. R. After that he was for some time engaged in gold mining in Nevada. Leaving the gold fields, he became president and chief engineer of the Western Indiana Construction Co.

The third annual meeting of the Iowa Section, American Water Works Association, was held Oct. 10, 11 and 12 at Council Bluffs, Ia. The following officers were elected for the coming year: Chairman, S. L. Etnyre of Council Bluffs; vice-chairman, W. A. Judd of Mason City; directors, G. E. Shoemaker of Waterloo and B. F. Stedman of Dubuque; secretary-treasurer, Jack J. Hinman, Jr., State University of Iowa, Iowa City. The next meeting will be held in Iowa City in the fall of 1918.

Henry G. Shirley, chief engineer of the State Roads Commission of Maryland, has been appointed a member of the highways transport committee, created by the Council of National Defense, to organize co-operation among transportation agencies for the more general use of public highways and inland water routes for short hauls. Roy D. Chapin of Detroit was made chairman. Other members of the committee are Logan Waller Page, federal director of public roads, and George H. Pride of New York. Mr. Shirley became chief engineer of the Roads Commission in 1912. Prior to this he was the roads engineer of Baltimore County, Maryland.

The Public Service Commission for the First District, New York City, has 257 employees in the Army and Navy. Two members of the Commission, Col. William Hayward and Maj. Henry W. Hodge, and many members of its staff are in one branch or the other of the United States service and some are already at the front in France. Of the above figure 228 are in the army service and the remainder in the navy. The October number of the Public Service Record, published by the Public Service Commission, has been issued as a patriotic service edition and contains the names of the men in service with their respective commands. The list of Public Service Commission men in the army includes: 1 colonel, 1 major, 16 captains, 15 first lieutenants, 34 second lieutenants, 1 battalion sergeant-major, 1 sergeant painter, 9 sergeants, 3 master gunners, 6 corporals, 1 bugler, 1 machinist, 17 officer candidates, 1 recruit, 1 student, 1 aviation cadet, 84 privates and 35 selective draft. The list of men in the navy includes: 1 captain, 1 lieutenant commander, 5 lieutenants, 3 ensigns, 3 chief electricians, 1 chief machinist's mate, 3 electricians, 1 chief yoeman, 2 yoemen, 4 seamen, 1 oiler, 1 musician and 1 boatswain's mate. The men in the service comprise approximately 15 per cent of the commission's staff.

Obituaries

Leander Delevan died Nov. 1 at Nelson, Cal., aged 85 years. He is stated to have built the first dredge operating in the Feather River.

John D. Crimmins, for many years a leading figure in the New York business world, and widely known for his charities, died of pneumonia Nov. 8 after an illness of four days. Mr. Crimmins was born in New York City, May 18, 1844, and entered the contracting business of his father. In 1873 he became head of the firm and for many years engaged in great building operations, principally for the Manhattan Elevated Ry., Consolidated Gas Co., Equitable Gas Co., and Western Union Telegraph Co.

Excavation and Govt. Works
Monthly Issue

ENGINEERING *AND* CONTRACTING

Halbert P. Gillette, *President and Editor.* Lewis S. Louer, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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ATTENTION!

Turn back three pages to advertising page 14. The publishers of Engineering and Contracting have there printed a message that should interest you.

The "Self-Identifying Check": Can It Be Used in Paying Construction Workmen?

Men engaged on construction work are seldom paid by check, because of the objections raised on account of the difficulty of cashing checks. This difficulty can be overcome by the use of a self-identifying feature similar to that of travelers' checks issued by express companies. On the face of the check a space is provided for the signature of the employe, and this signature is written in the presence of the paymaster. Then if the employe endorses the same check on the back in the presence of a bank cashier, or other person who cashes the check, the agreement of the two signatures is sufficient evidence that the right person is cashing the check. By arrangements with banks and merchants the cashing of self-identifying checks can be effected in any city, with resulting saving of time in payroll work and complete elimination of risk of theft or robbery.

How a Contractors' "Cafeteria" Eliminated Camp "Flunkies"

Camp waiters, or "flunkies," have so long been regarded as a necessary evil that there is some shock of suprise in the announcement that one contracting firm has devised a way of eliminating "flunkies" entirely. Fred T. Ley & Co., contractors for the army cantonment at Ayer, Mass., had the wit to adopt the cafeteria method of serving their men—or rather of making the men self-serving, auto-flunkies, as it were. With "loading counters" covered with food, aisles down which the men marched past cash registers and eating tables on which their trays of food were placed, it was possible to feed 2,500 men without confusion and quickly. The men either bought meal tickets or paid cash, at their option. The camp cafeteria has proved to be so pronounced a success that it will undoubtedly be adopted by many a contractor.

The Use of Air Hammer Drills for Large Diameter Holes

The air hammer is commonly regarded as being adapted only for drilling holes of small diameter; but R. C. Starr, chief engineer of the Southern California Edison Co., Los Angeles, has found it practicable to drill 5-in. holes 3 ft. deep in cyclopean masonry, using air hammers. Three such holes were drilled per hour, with Leyner-Ingersoll hammer drills of the kind used in tunnel work. (See Gillette's "Handbook of Rock Excavation," p. 136.) But instead of mounting the drill on a quarry bar or tripod, it was fitted with a handle and operated by two men. The drill cuttings were not removed by water, as is common with the Leyner-Ingersoll drill, but by a compressed air blow pipe. The holes drilled in this manner were used as anchorage places for steel anchor rods. However, the economic drilling of such large holes with air hammers suggests possibilities of using this type of drill for putting down large, shallow blast holes in confined places.

The Use of Chutes for Stacking Sand, Gravel or Stone

Stock piles of sand, gravel or stone may be built up with the aid of steel chutes, such as are used in delivering concrete from tower hoppers into the forms. The Pittsburgh Railways Co. piles ballast in its East Liberty storage yard in the following manner: The freight cars dump into a hopper under the track, and the hopper feeds into a bucket that is hoisted up an inclined track and dumps automatically into a small hopper such as is used on concrete work. The ballast is delivered from this hopper through steel chutes, as in chuting concrete, into stock piles. The flexibility of such an outfit is apparent. Evidently the concrete tower and chute has uses not hitherto thought of by many contractors or engineers.

Uncrushed Rock from Tunnel Heading Used in Concrete Lining

It has frequently been suggested that rock for concrete tunnel lining might be taken direct from the tunnel heading, mixed with sand and cement and placed in the forms; but the first tunnel in which this plan has been carried out is the Wilson avenue intake tunnel for the water supply of Chicago. The rock, which is a limestone, was broken up fine by the blasting, so that enough suitable stone under 4½ in. diameter could be secured by screening the "muck" from the heading. Muck cars (1 cu. yd.) were hauled up an incline in the tunnel and dumped onto a screen. The screened stone was delivered upon a belt conveyor feeding into a hopper above the concrete mixer. A pneumatic mixer, furnished by the Concrete Mixing & Placing Co. of Chicago, was used. The mixed concrete was carried through an 8-in. pipe by air pressure to the Blaw steel forms, the maximum distance of travel being 1,000 ft. During one month 2,800 cu. yds. of concrete were thus placed, the operating crew at the mixer being 13 men, including the men who screened the rock. The pneumatic method of conveying the concrete made it possible to line the tunnel while the excavation was in progress, and thus a saving of a year's time was effected.

Railway Cuts and Fills Economically Made with a Dragline Scraper

In grading the Lorain, Ashland & Southern R. R. a large part of the excavation was done with a dragline scraper, wasting the cuts and borrowing for the fills. This necessitated buying additional right of way, but the cost of the land was nominal and far less than the saving in the cost of hauling the earth from cut to fill. In making a high fill borrow pits were dug on each side up to a width of 80 ft. The machine handled much of the earth twice in these wide pits. This work was done with a Bucyrus dragline by the Essex Construction Co. of Buffalo. The material was mostly clay, but the side slopes of the cuts were not dressed by hand as they were left fairly uniform by the bucket.

Where one machine with a relatively small crew can move 40,000 cu. yd. in 6 weeks, as was done in one cut, it is evident that this method of railroad grading deserves more consideration than it has hitherto received.

Economic Thawing of Earth With Steam

Those who have had no experience in thawing frozen earth with steam often make the mistake of thinking that bare steam pipes laid on top of the ground under a cover of canvas, will be effective. But the heat is radiated into the air so rapidly that the thawing is very slow and expensive. If the steam pipes are covered with 6 or 8 in. of sand, the thawing is much more efficient. Even better where the amount of earth to be thawed is considerable, is the following method. Bore a hole in the frozen earth, using a steam pipe, open at the lower end, to thaw and displace the earth. A ½ to ¾-in. pipe can thus be forced down to a depth of 3 or 4 ft. in a few minutes. Then insert another length of steam pipe in the hole, this pipe being capped at its lower end and having 4 to 6 small (⅛-in.) holes drilled in its sides. Have this thaw pipe project above the ground a foot or two and connect its upper end with a steam hose to the main steam pipe which feeds a group of such thaw pipes. Frost to the depth of 3 or 4 ft. can be very rapidly thawed in this manner.

Opportunities for American Contractors and Engineers in France After the War

The rehabilitation of cities in France and Belgium after the war may profitably engage the attention of American engineers and contractors right now. Elsewhere a letter from J. A. L. Waddell gives portions of a correspondence between him and a French engineer, who seeks the co-operation of American contractors and engineers. This French engineer evidently believes that American machinery, capital and brains will be in demand at the close of the war, to rebuild the devastated industrial centers of northern France. In our last Road and Street Monthly issue, Nov. 7, we predicted that the American road builders (the "23rd Engineers") who are going to France will revolutionize French methods of road building mainly by introducing American machinery. May it not also happen that other Americans will also effect great changes in other lines of construction? Concrete buildings, for example, have long been erected in France, but never on the scale nor with the rapidity prevalent in this country. Let some of our energetic American contractors and engineers ally themselves now with French associates, and prepare for the work that will follow the ending of the war.

Combination of Steam Shovel and Hydraulicking Methods of Dam Building

In building an earth dam with steam shovels and cars there is a difficult economic problem involved in spreading the earth. If the track is shifted laterally, in order to spread the earth in comparatively thin layers, the expense of track shifting becomes a very large item of cost. In a timbered country where trestles may be cheaply built, it is feasible to dump from a trestle and then spread the earth with a dragline bucket. In an arid country where timber is expensive, this method may not be advisable. R. C. Storril & Co., San Francisco contractors, are building an earth dam 75 ft. high near Las Vegas, N. M., in a manner that merits attention. A 40-ton Vulcan shovel loads 4½ cu. yd. cars that are dumped on the two slopes of the dam. A hydraulic giant sluices the earth, which is a heavy clay mixed with sand and gravel, toward the center of the dam. The water for sluicing is delivered by gravity. This combination of shovel, cars and hydraulic monitor is one that may frequently be used with profit in building large water tight embankments, the materials for which must be well spread and compacted.

In building the Patillas irrigation dam the government of Porto Rico recently used a combination of steam shovel, cars and hydraulic monitor that differs somewhat from the above described method. The dam is 135 ft. high. Trestles 50 ft. high were built on opposite sides of the dam, and earth was dumped through these trestles forming two dikes. After the trestles were filled in, the dikes were built up higher by successive lifts, shifting the tracks back and forth. Hydraulic monitors washed the earth from the inner sides of the two dikes to a pool of water between them. The pipe line was supported on pontoons floating in the pool. A 6-in. centrifugal pump, driven by a 60-HP. engine, was used for the higher part of the dam when the gravity pressure was insufficient.

The Growing Use of Labor-Saving Machinery on Railway Maintenance

The scarcity and high price of labor is driving railway companies to use more machinery in connection with track maintenance. This was well shown in an article entitled "Labor Saving Equipment for Track Work on Illinois Central R. R.," published in our Oct. 17 issue. Steam ditchers, of the boom type, repay half their first cost in a year, and air dump cars repay one-quarter their first cost in a year; this, too, when they are used only 6 months out of the 12. Track-laying machines have proved equally profitable, and air operated rail loaders are now regarded as indispensable. Tool grinders have displaced the old fashioned grindstones, and oxyweld repair outfits are now used where a blacksmith would have spent hours or where a broken tool or part would have been scrapped. Wideawake railway contractors are also studying the posibilities of labor saving devices as never before.

Why Are Air Hammer Drills Not Mounted More Commonly on Tripods?

An air hammer drill, weighing about 40 lb., can be used to drill a hole 15 ft. deep if mounted on a tripod or quarry bar; and it requires but one man to operate it. A gang of 4 or 5 hammer drillers needs but one helper, whereas a similar gang of drill runners operating piston drills would have a helper for every driller. The owners of certain marble quarries have found it economic to substitute hammer drills for piston drills. Of course, the diameter of an air hammer drill hole is smaller than that of a piston drill, which is an objection where heavy blasts are to be fired—unless the holes are chamfered at the bottom. But in excavating rock that is not tough and is jointed, it would seem that the air hammer drill mounted on a tripod is a tool that has not been used as extensively by contractors as it should be.

Timber Trackways for Motor Trucks

The economic operation of large motor trucks over earth roadways is often rendered impracticable because of the soft condition of the soil. This is noticeably so where trucks are loaded with earth by a steam shovel. In such cases it frequently pays to lay a timber trackway, at least across the worst spots. Such a trackway may consist of 10x12 timbers, two of which, side by side, form a track for one wheel. Although the first cost of such a trackway may be large, the salvage value of the timber is considerable. Stringers of old freight cars and other second-hand timbers may be frequently secured at a low price for such trackways. It should be remembered that 5-ton trucks soon knock a plank road to pieces unless its stringers are well bedded in the soil, and that rainy weather causes a pumping of mud out from under the plank; whereas heavy timbers make a trackway that is easily kept in good condition and is readily shifted to a new location.

Give the Railways Higher Rates

For several years railway construction has been almost at a standstill, largely because the Interstate Commerce Commission and the various state railroad commissions have failed to permit the railways to make adequate net earnings. New capital has been difficult to secure, for investors have preferred to put their money into "industrials" and "utilities." Once again the railways are appealing to the I. C. C. for a 15 per cent increase in freight rates, this time with some show of success. The present inadequacy of our transportation system has been made strikingly apparent. Since this inadequacy is directly traceable to the inability of the railways to sell new issues of stock, the I. C. C. is likely at last to abandon its policy of giving the railways only crumbs where loaves are sorely needed.

Bids on Miami Valley (Ohio) Flood Control Works Unsatisfactory

Bids were opened Nov. 15 by the Miami Conservancy District of Dayton, O., on 12 contracts covering the construction of flood control works in the Miami Valley, involving 6,000,000 cu. yd. of excavation, 9,000,000 cu. yd. of embankment and 260,000 cu. yd. of concrete. All proposals, except on two of the items, were informal and conditioned on prices of labor and materials, on the attitude of the national government toward construction work, or on other possible developments. Some of these indicated unit prices not far from the estimates of the district, but the conditions attached would make the final price indefinite. All proposals were rejected except those of R. H. & G. A. McWilliams on contracts 41, 43 and 44, covering about $1,000,000 of channel improvements in Dayton. In these the conditions were such as to make the maximum cost about 10 per cent over the engineers' estimate. These three proposals have not been accepted, but are held for further consideration.

Proposals were received from: H. P. Converse & Co., of Boston, Mass.; United Dredging Company, of Seattle, Wash.; R. H. & G. A. McWilliams, of Chicago, Ill.; Parsons Construction Company, of Binghamton, N. Y.; M. C. Connors & Company, of Chicago, Ill.; Winston & Company, of Richmond, Va.

Hunkin-Conkey Co., of Cleveland, presented unconditioned proposals on two dams, but these were received after the bids had been opened and read, and so were not considered.

The Board of Water Supply of New York City has awarded the contract for the construction of the Shandaken Tunnel to the Degnon Contracting Co., Long Island City, N. Y.

International Alliance of Engineers, Contractors and Manufacturers for Reconstruction Work After the War

To the Editor: For some time I have been in correspondence with certain prominent French engineers concerning professional matters relating to reconstruction after the war. One of them, a young officer in the army now at the front, and the son of one of the best-known civil engineers of France, has been asking me various questions about how to get in touch with American engineers, contractors, and supply men. Not understanding exactly what he wanted, I furnished him with the best information I could, and asked him to explain more fully that which he had in mind. In reply I received a letter, from which, after translating, I extract the following:

> I wish to prepare from now on the work which I shall be able to occupy myself after the war, and specially to enter into relations with individual Americans or organizations of which I believe the collaboration to be necessary.
>
> The projects in which I would like to interest this collaboration are in their great lines the following:
>
> Reconstruction of certain industrial districts devastated by the war, and of which the economic life should retake an active stride. For this end there is necessary the formation of a construction company which will become conversant with the industries and the municipalities for the purchase of suitable lands and the preparation of the general conditions of work, comprising notably:
>
> Contracts with furnishers of materials of construction (at a pinch, equipment of auxiliary manufactories for the preparation of these materials—bricks, timber, lime and cement). Entente with the public powers for the establishment of surveys of towns and the study of questions relative to public services (municipal or community constructions, stations, bridges and roads, distributions, canalization, etc.). Negotiations with companies or individuals desirous of reconstructing their shops and their residences.
>
> The works of construction properly so called will be undertaken by modern methods, installations of rational storage yards, and a perfected equipment permitting of producing in series with the maximum of rapidity and the minimum of hand-labor.
>
> I am convinced that the collaboration of American engineers would be specially useful to us in the reorganization of the devastated regions, on account of their experience in the matter of city planning, their methods of rapid execution, and their modern means of action.
>
> In particular, they will know how to evolve suitable solutions of the problem of workmanship, of which the crisis will be very serious in Europe after the war.
>
> That collaboration could be exercised—either by the adjunction of American specialists to French enterprises; or by the installation in France of American enterprises to which would be joined French engineers.
>
> In any case there will be the necessity of procuring an appropriate equipment of works; and by that term I mean all the outfit necessary for the works of construction of cities, to-wit: Concrete mixers, cranes, derricks, aerial transporters, riveters, installations of electric power and compressed air, rolling stock, etc.
>
> It will be without doubt advantageous to buy this material in the United States to supplement the materials of construction which we shall lack, such as cement, wood and metallic constructions.
>
> In résumé, in order to be able to study from now on the realization of these different points, I should like to be able to enter into communication with the following persons:
>
> Engineers specializing in the question of construction of private, industrial and public buildings, and, in a general way, of city planning. Contractors capable of coming to execute works in Europe. Furnishers of materials of construction. Individuals or companies desiring to interest themselves in an enterprise of reconstruction of that kind, either in execution, or by participating in financing.

From the preceding it is evident that my correspondent really means business; and, consequently, I should like to put him in communication with American engineers, capitalists, contractors, and supplymen, provided that these gentlemen also mean business, and that they are properly equipped financially and in other ways to do the work contemplated.

I do not feel at liberty to mention in print my correspondent's name; but through the New York office of my firm I could put in touch with him any individual or corporation of the proper stamp desiring to correspond with him. In my opinion, as many arrangements as possible looking towards the international alliance of engineers and others herein contemplated should be made before the close of the war, so that as soon as peace is concluded the work of reconstruction may be started.

Such a professional and financial alliance might be the means of bringing a large amount of business from Europe to this country; consequently, if there is anything I can do to aid in forming it, my services and best endeavors will be available. In self-protection, however, I must state that I do not want to get into correspondence with anyone who is merely looking for employment, nor with any promoter who is not directly able financially to help in the undertaking. My New York office address is Room 500 at 165 Broadway.

J. A. L. Waddell,
Kansas City, Mo. Consulting Engineer.

A Foundation Problem

To the Editor:

We are endeavoring to find some information regarding any previous successful solution of a foundation problem as stated below. We are having an extensive search made in the Engineering Societies' library in New York. We are writing to a considerable number of prominent contractors and engineers and calling upon others to see if they have had personal experience with or know of any similar conditions which have been successfully solved.

We desire to call in consultation an engineer who has had the proper experience in this direction.

Our problem briefly consists in securing a foundation for a dam and powerhouse in a valley where the upward artesian flow is so great as to destroy the frictional resistance of round piling, 60 ft. long. The water follows up along the piles and they settle, sometimes at the rate of an inch per day, by their own weight. In portions of this same foundation area, which is coffered and pumped down to about 15 ft. below normal river surface, there are locations where the soil is exactly similar but where the flow is less or not close up to the piling, but within 10 ft. of the piling, and these piles are each sustaining, without settlement, loads of 20 to 25 tons on 60-ft. piles with 7-in. points. Our problem, then, seems to be to drain away this artesian flow before it can attack the piling in the area which we enclose with steel sheet piling about 40 ft. in length.

We enclose extracts from our instructions and explanations to the search engineer in New York, which will give you further information if you are interested to read it. Our thought is that with your extensive experience you might have had or know of a similar case, or could suggest to us a consultant who has.

We are satisfied in our own minds that we can obtain a foundation if we can get rid of the water under pressure, and the problem is one of practical details for handling this water. An explanation of the soil conditions will be found in the accompanying abstract. The means for keeping any bleeder wells from being clogged with the fine sand is our present greatest problem.

———————,
Hydraulic Engineers.

[The extracts from the instructions to the search engineer follow. We shall be glad to hear from any of our readers who have had experience in a similar case.—Editor.]

Extracts from Instructions to Search Engineer.

In explanation of our problem would say that one of our clients has started to build a dam to retain 40 ft. head of water on a river about 100 ft. in width, with a bluff some 60 ft. high on one side close up to the river and a lower bluff nearby on the other side, with higher ground up to 100 ft. or more on both sides of the river within half a mile of there. The general soil of the valley is sand with occasional thin gravel strata and intermittent beds of clay of varying thicknesses. A large number of wash borings have been made in the valley at a maximum depth of about 100 ft. below present river surface. At the dam site, the typical section is as follows:

Beginning at the surface of the river, fine sand and slit, average	25 ft.
Blue clay merging into quicksand, 10 to 20 ft.	15 ft.
Clay with sand and quicksand, 10 to 20 ft.	15 ft.
Then, medium fine water silica sand	45 ft.

No holes have gone through this sand. An analysis of the sand shows the following:

GRANULAR ANALYSIS OF WATER SAND TAKEN 60 TO 70 FT. BELOW RIVER SURFACE.

Test sieve No.	Clear opening standard sieve inches.	Per cent passed by sieve.	Opening of well screen, inches.	Well screen No.
20	0.034	98.7	0.035	35
			0.030	30
			0.025	25
30	0.019	67.2	0.020	20
			0.014	14
50	0.011	15.0	0.010	10
			0.008	8
80	0.007	5.3		
100	0.006	1.5	0.006	6

It was the original intent to drive sheet and round piles and found the structure in this way on the clay stratum, which, from the borings, was supposed to be continuous over a considerable area, but some faults and perforations caused the quicksand to come up from below, and eventually the clay settled before any round piling had been driven. Settlement to date has been about 7 ft. maximum, in the upstream corner of the foundation area, next to the high bluff, which is on the right hand side of the river.

It was then planned to open up sufficient holes through this clay to bleed out the quicksand and similar materials and allow the clay to settle onto the water sand below and to drive piles 60 ft. to 70 ft. long reaching down into the water sand. Some 50 to 65 ft. test piles have been driven. One of these is driven at a point where the quicksand had all disappeared owing to the action of the flow upward. This pile was carefully loaded and it settled 9/16 in. during loading and up to 48 hours. In the four days following, to date, there has been no further settlement under 20-ton load, although there was some considerable spring coming up about 5 ft. away. The second pile was in the region of greatest settlement in upstream corner, next to high bluff where real quicksand had disappeared. This pile was surrounded by six others in a circle, about 3-ft. radius, to approximate the conditions that would obtain after the piles for the foundation were driven. The flow at this point was so excessive that the frictional resistance is quite low, and these piles are settling from their own weight at the rate of an inch or more per day.

The discharge from the area of present cofferdam, which is roughly 100 by 200 ft., amounts to 500 to 1000 gal. per minute. The pit is at present pumped down to about 15 ft. below river surface. There was no evidence of springs at the site before the low clay stratum was punctured by drill holes and piling.

We would explain in general regarding the watershed of this river that most of the rainfall comes to the river by underground flow. There are only three or four tributaries in a distance of 60 miles, the largest of about 100 c. f. s., the next of about 25 c. f. s., and the others less than 12 c. f. s. normal flow, but throughout the length of the stream there are springs and a trickle of water nearly everywhere along the banks.

A few miles further downstream there is a heavy clay bed, extending for many miles and coming to the water surface or higher, on which we have built three successful dams and are building a fourth, heads up to 40 ft.

There is no rock within several hundred feet from river surface, and it is inexpedient to go to greater depth than 100 ft., and probably not for more than 60 or 75 ft., for any form of a foundation. Our problem, therefore, seems to be to find means to drain away this artesian flow in the foundation area and prevent the rise of quicksand and other fine material, and prevent, also, the following of water up along the piling, reducing the frictional resistance. The object of our search, then, is to be put in touch with actual situations approximating these conditions.

We would look with most favor on American data not over 20 years of age, as it is usually difficult to follow up older data and secure sufficient details to serve our purpose. Also, at the present time it will be difficult to follow up, within a reasonable period, any foreign data or get in touch with the actual construction organization, but, of course, where the published data is sufficiently complete, it would be of interest.

Comments on "Extra Work" Clauses

To the Editor: In the Engineering and Contracting issue of Oct. 17, 1917, is an interesting article on the "Extra Work" clause of the Miami Conservatory District of Ohio.

This in general is an excellently worded clause and reflects credit on the engineer responsible for it, except for one item as follows. The clause takes for the use and benefit of the conservancy district the following expenditures of the contractor, without pay:

1. Overhead charges. 2. General superintendence. 3. General expenses. 4. Contingencies. 5. Depreciation of, wear and tear upon plant. 6. Maintenance of contractor's camp, except in case such camp be maintained primarily for extra work.

This discussion is predicated on the assumption that the 10 per cent or 15 per cent extra paid to the contractor is paid for the benefit derived by the owner for the use of the contractor's personal time and business, engineering and executive abilities, knowledge and experience to organize a construction force, to buy materials, through the use of his financial credit and capital, and to be the agency through which the desired work is constructed. These are things which the existence of a contract between the parties is conclusive evidence that the owner or engineer desires from the contractor and for which the contractor is paid.

Items 1-6 above are outside this range of activity fully as much as the manual labor itself entering into the extra work.

Engineers who, as contractors, have made expenditures under these five items, and by accurate bookkeeping charged to the extra work its proper expense, will realize that the small residue left of the 10 per cent or 15 per cent remuneration may not be an adequate payment for undertaking the extra work.

Why should an engineer saddle upon a contractor the unknown and unlimited "contingencies"? Why should an engineer take and use and wear out a contractor's plant free of cost?

Let him pay as such for services rendered in an open and above-board manner, and not make a contractor's pay a speculation as to whether the 10 per cent or 15 per cent will be an actual loss or an adequate remuneration for all the contractor's services.

The elimination of all possible uncertainty of expense to a contractor will redound to the benefit of the owner by a lowering of contract prices. Many a bid contains prices raised to cover the unknown charges which experience has taught contractors will ensue from the otherwise unpaid expense of doing extra work.

It is clauses like this one in question which cause some contractors to feel that the engineer is legitimate prey to overcome by any and all means. It is not good business for an engineer to write a code of ethics and pose as an altruistic judge between owner and contractor when he voluntarily becomes the owner's servant and writes into a contract a clause which throws concealed and variable charges upon the contractor. Victor Windett.

Chicago, Ill.

Why Some Contractors Fail to Make Money

From time to time there is extended discussion of why contractors fail to make money. One sees discussions of the subject bearing on almost all phases of the matter, but rarely is there any question as to the competency of the men who hold the contracts. And, indeed, this is not a surprising thing, for contracting is an honorable and an honored business, and many who engage in it are among the leading men of the day.

On the other hand, many small undertakings, especially in the line of public works, fall into the hands of men who are not possessed of great experience and who, no matter how well they intend to do, are nevertheless handicapped by this lack of experience. This has occurred to the writer repeatedly as he has had occasion to visit small jobs and has had opportunity to observe the wonderfully low efficiency in handling men which many small jobs show, and it has often been a question in his mind as to whether the ordinary foreman knows how to find out even the most elemental facts as to how steadily his men are working.

One very good way to do this is to find a place where one can watch a force of men at work without being too closely observed and then count the idle men, the count being repeated every minute over a period of 15 or 20 minutes and repeated two or three times a day. Thus on a job in Iowa the following record was recently made:

On the job: One foreman, 1 inspector, 8 laborers, in sight. (There were two or three others on the job who could not be seen from the point where the counts were made.)

Count.	Men idle.	Men at work	Count.	Men idle.	Men at work.
[illegible]	4	4	2:11	5	3
[illegible]	4	1	[illegible]	7	1
[illegible]	6	2	[illegible]	7	1
[illegible]	3	5	[illegible]	4	4
[illegible]	8	0	[illegible]	6	2
[illegible]	5	[illegible]			
[illegible]	6	2		74	46
[illegible]	4	4			
[illegible]	[illegible]	5			
[illegible]	2	6			

Average at work, 3+.
Average idle, [illegible]

The unescapable impression which this simple count gives is that more than half of the time of the men employed on this job was being lost. If to this one adds the time of the foreman who in this case did nothing but "boss the job" the condition of affairs seems even worse.

There is nothing new or original in this simple count to determine the elementary question as to how much positively wasted time there is on a job, but if more contractors would adopt it there would be more of an effort to save labor by arrangements of the force which would eliminate the lost labor.

On the job in question, a mixer was running at full speed during the whole period of the count. It had been running for some hours before the count was taken and ran on after the count was made. Three of the eight men fed sand and gravel to the mixer. The sand and gravel were not separate, but were mixed together, the aggregate being a run of pit material used without screening. One of these men was always idle. Two should have fed the mixer with ease even though it seemed that the aggregate had been unloaded farther from the mixer than was necessary or advisable.

One man brought cement to the mixer. He was a dead expense, and idle over half of the time. The cement could just as well have been unloaded on a platform where the man who tended to the mixer could have gotten at it without assistance.

Another man pumped water for the mixer. A small power pump connected to the mixer engine should have handled this work. This man was idle two-thirds of the time.

The man to tend the mixer was needed, but the man who dumped the mix and shoved it down a trough set at a light slope when it should have been set steep enough to permit the concrete to run or, better still, when the mixer should, as in this case, have dumped direct into the forms, was a dead loss.

The man who tamped the concrete in the forms was needed, but he should have also tended to dumping the batches as they were mixed. Thus, careful management would have cut this force of 8 men to 4 men and it is not asserting too much to say that none of the four would have been overworked.

Inquiry was made as to the financial side of this job. It had lost money! No wonder. Using two men to do one man's work is seldom profitable.

Possession of Explosives Now Illegal Except Under U. S. License

A war measure of particular interest to contractors and quarrymen went into effect on Nov. 15. The measure provides that everyone who handles explosives must have a license. The manufacturer, the importer, and the exporter must have licenses issued by the Bureau of Mines in Washington. The seller of explosives and the purchaser of explosives must also have licenses, these to be issued generally by county clerks or other local officers who are authorized to administer oaths. There will be at least one licensing officer in each county, and more agents will be designated if the county is sufficiently large to warrant it. If a State has laws providing for a system of licensing persons manufacturing, storing, selling, or using explosives, the State officials authorized to issue such State licenses will be designated as Federal licensing agents; also city officials qualified to issue city explosives licenses will be given authority to issue Federal licenses. A Federal license will not relieve any person from securing licenses required under State laws and local ordinances. In each State there will be appointed a State explosives inspector, who will represent the Bureau of Mines in the administration of the law within the State. Only citizens of the United States or of countries friendly to the United States and the allies may so obtain licenses. Contractors, mining companies, quarrymen, and others using large quantities of explosives, which are handled by employes, may issue explosives to their employes only through those employes holding a license called a foreman's license. The purchaser of dynamite in obtaining a license must state definitely what the explosive is to be used for and will be held accountable for its use as stated and the return of any explosives that may be left. With the strict enforcement of this law, the Federal authorities hope to prevent explosives falling into the hands of evilly disposed persons and to put a stop to all further dynamite plots.

The Housing and Feeding of Construction Forces

At the recent convention of the American Railway Bridge and Building Association an excellent paper on the housing and feeding of bridge and building maintenance of way crews was presented by Mr. F. E. Weise, Chief Clerk, Engineering Department, Chicago, Milwaukee & St. Paul Ry. The paper contains so many suggestions of interest to construction engineers and contractors that it is reprinted below, practically in full.

When it has been decided that a camp is to be established the site of the work should be examined carefully, and the location of the camp determined by considering the conditions that will make it habitable. Location, water supply, drainage and sanitation should be given careful study.

If the camp is to be located on the railway company's right of way, the space may be limited and the buildings will have to be placed in a row. If so, the office building should always be placed between the dining and the sleeping quarters. In some cases sufficient unused land is available so as to allow a more compact arrangement, and in others the physical conditions will, in large measure, control the layout. Camp buildings should be located on high ground whenever practicable so that the natural drainage is away from the buildings and insures rapid drying out after rains. The arrangement of the buildings and the plan of the buildings themselves will depend somewhat on the location, the material that is available for their construction and the season of the year during which the camp is to be in use. If the camp is to be in operation during the winter as well as the summer the buildings must be of a more substantial type that will withstand stormy weather and keep out the cold. A camp which is to be used only a few months in the summer time may be of a very temporary form of construction. Most large pieces of work requiring construction camps are apt to extend over a period of a year or more, and while the buildings are styled temporary buildings, they must be substantially built.

All camp buildings should be built high enough above the ground to enable a man to clean up underneath. The space under the building is then easily inspected and no old clothes or rubbish should be allowed to accumulate. In the autumn this space should be enclosed as a protection against cold. The buildings should be equipped with stoves or other heating apparatus, not only for the warmth of the occupants, but to dry the rooms out in damp weather.

The office building should be of construction similar to the other camp buildings, and large enough to provide for an office for the transaction of business and the performance of the necessary clerical work and drafting, and a storeroom for the camp supplies and the commissary. Sleeping quarters for the engineer and office force should also be provided, either in the same building, or in a lean-to communicating with it.

Dining Room and Kitchen.—For the average camp, the dining room and kitchen should be in one building and separated by a partition. In the dining room end sufficient tables should be provided so that the entire force may be served at one time. When the camp is not too large, the building should be long and narrow, the dining room being at one end and the kitchen at the other with entrances at each end and a communicating door between the kitchen and dining room. The dining room should be wide enough to provide for two long tables at the sides with an ample aisle between, which will permit waiters to pass back and forth freely. This form of building can be loaded on a flat car and transported from one location to another. For larger camps it may be better to construct the building in the shape of a "T," in which the dining room is one large room and the kitchen an annex at the center of one side.

Another good plan consists of three adjoining buildings placed in the form of a letter "U," and provides for two separate dining rooms with a common kitchen. This plan is desirable where the force is apt to fluctuate. When the force is small, one dining room may be closed, and as the work nears completion, one building may be removed without interfering with the camp routine.

Whatever the arrangement decided upon, provide liberally for windows, in order that in cold weather, the dining room will be well lighted and in hot weather the windows can be thrown open. Nothing is more conducive to cleanliness than plenty of light, and it is the common experience that rubbish will accumulate in dark places. Screens for windows and doors are an absolute necessity, and a constant effort must be made to eliminate flies, ants, roaches and other pests. Frequent scrubbing with a liberal use of hot water and soap will be of great help, and a good rule is to scrub the kitchen every day and the dining room twice a week. The dining room and kitchen floors should be swept after every meal.

It is usual to provide long tables about 30 in. wide with long benches at each side. Sometimes smaller tables are provided, seating four to six men each, but it is found that this plan requires more waiters and that the men cannot be served as quickly. It will be found more satisfactory to the men to eat at the same table with those they work with and, therefore, each man is assigned to a definite place by the clerk in charge of the camp. The tables should be strongly built and the top at least made of surfaced lumber in order that it may be kept clean.

Kitchen Utensils, Dishes, Etc.—Considerable thought should be given to the selection of this part of the outfit. The kitchen utensils should be chosen for their utility. They are in constant use and must be strong and durable. Without being unnecessarily extravagent, select ware that can most easily be kept clean. A little expenditure on quality is a good investment here, because the cook and his helpers will take pride in keeping good equipment in good condition.

The dishes in the dining room should be of a good grade of heavy china or crockery. Tin or enameled dishes have found favor in the past because of their overrated quality of unbreakableness, but this is more than offset by their disadvantages. Tin dishes are hard to keep clean, or at any rate clean looking. Steel knives rubbing on tin or enamel produce a disagreeable and irritating noise, and also are apt to chip off the enamel. They allow the food to get cold too quickly.

Not only can crockery be kept clean more easily, but it adds more to the meal than at first thought seems possible. An office man may find it a little difficult to appreciate this. Should he go on a hunting or fishing trip for a few days, he rather enjoys having his meals served in tin dishes. As a matter of fact, it is the novelty of the change that he enjoys. Unaccustomed activities, together with unlimited fresh air, make him so ravenously hungry that he takes no account of the service. How long would the novelty last? The man in the construction camp is in a different position. Camp life is his daily existence, and there is a natural craving for better things. The same food will be twice as appetizing if served on crockery than if served on tin or enamel, and it makes the man feel that he is considered somebody. Actual experience shows that the breakage of crockery is not large and that its expense is not much greater than other ware. The following list will serve as a guide in preparing for the first requirements of a camp of about 50 men:

KITCHEN UTENSILS

1	Range for coal, 28"x54".	2	Roasting pans, 22"x22".
2	Griddle irons, 16"x24".	2	Cake turners.
6	Galvanized pails, 12 qt.	2	Galvanized tubs.
2	Washboards.	1	Stock pot, 5-gal.
2	Stock pots, 10-gal.	1	Boiler, 20".
6	Sauce pans, 6½-qt.	6	Colanders.
4	Dish pans, 30-qt.	6	Pudding pans.
4	Frying pans, 12".	4	Soup ladels.
1	Skimmer.	2	Basting spoons, 18".
2	Flesh forks.	6	Water dippers, 1-qt.
2	Funnels.	1	Measure, 1-gal.
12	Pie tins, 9".	6	Bread pans, 11"x7".
12	Coffee pots.	2	Potato mashers.
1	Pot chain.	1	Flour shaker.
1	Flour scoop.	1	Grater.
1	Nutmeg grater	1	Egg whip.
2	Rolling pins.	1	Cutting board, 18"x24".
1	Pastry brush.	1	Meat chopper.
3	Can openers.	12	Tin cups.
1	Coffee strainer.	1	Scale with scoop.
2	Butcher knives.	2	Bread knives.
6	Paring knives.	1	Butcher's steel.
1	Cleaver.	1	Meat saw.
1	Ice pick.	1	Ice tongs.
6	Scrub brushes.	6	Wash basins.
12	Dish towels.	24	Roller towels.
12	Waiters' aprons.	2	Mirrors, 9"x12".
1	Alarm clock.		

DINING ROOM.

Crockery.

60	Coffee cups.	60	Saucers.
60	Dinner plates	6	Platters, 13".
6	Platters, 11½".	36	Vegetable dishes.
60	Soup bowls.	12	Sugar bowls.
12	Butter dishes.	6	Milk pitchers.
6	Water pitchers.	60	Sauce dishes.

Glassware.

6	Vinegar cruets.	6	Syrup jugs.
6	Salt shakers.	6	Pepper shakers.
60	Water tumblers.		

Cutlery.

60	Knives	60	Tea-spoons
60	Tablespoons.	60	Forks.

Kitchen.—Whether the kitchen is part of the same building or not, it should communicate directly with the dining room, but be separated from it by a partition and a screen door. There should be a door opposite the dining room through which supplies and fuel are received and refuse taken out. It should also be provided with plenty of windows and a ventilator in order that the heat and odors from the range may be kept from the dining room. In the summer time the windows and doors should be screened. The kitchen should be equipped with a range, serving table, sink for washing dishes, cupboard, shelving and a pantry. The pantry is used to store such supplies as are required from day to day, but not in any large quantity. The large stock of supplies should at all times be kept in the storeroom that connects with the office, and the cook will draw therefrom what is needed from day to day.

The cook and his helpers should have sleeping quarters either in the main building or adjoining the dining room, but if in the same building, they should be completely partitioned off from the dining room, and the door be kept closed.

A refrigerator should be provided, and it will be best to have this a separate building located conveniently to the kitchen. This can easily be constructed from matched lumber. The one shown in Fig. 1 is inexpensive and easily built.

For a camp lasting several seasons, a cellar, roofed over and covered with earth, will provide an excellent place for keeping potatoes, beets, turnips and other vegetables.

The force required for a camp of about 150 men will consist of a cook, three flunkies and a commissary clerk. Larger camps will require additional help in proportion. Much depends upon the cook in the conduct of the camp, not only in providing satisfactory meals, but also in keeping the expenses within proper limits. In small camps and where the cook is found to be thoroughly reliable, it may be practical to furnish him supplies from day to day without keeping a daily record, but in the larger camps, it is necessary to require him to make requisitions for such supplies as he needs to equip the pantry from day to day. These orders are filled by the commissary clerk, who enters the prices opposite each item, thereby keeping in touch with the daily expense of the camp. The commissary clerk is to keep records of all supplies received from day to day, and of all supplies turned over to the cook each day, and on the morning of the first day of the month he is to make an inventory of all supplies on hand. At the time the inventory is taken, he will make up a statement showing the cost of the supplies used for meals, and all other expenses in connection with the camp, such as oil, fuel, wages, etc. He will keep a record of the number of meals served each day, and at the end of the month will make up a complete statement showing the expense of the camp for the current month, the number of meals served, and the average cost per meal, and also the same information for the entire period since the opening of the camp. Blank forms are submitted which are all very simple and need no further elaboration.

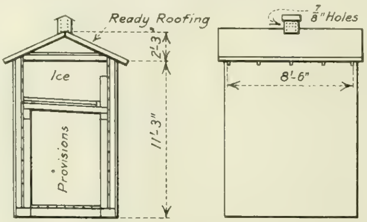


Fig. 1—Inexpensive and Easily Built Refrigerator.

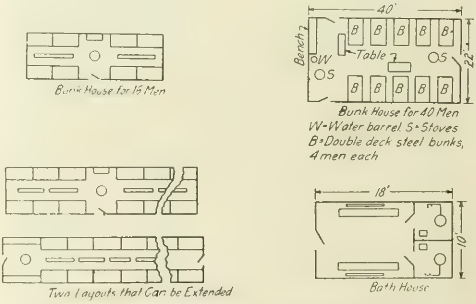
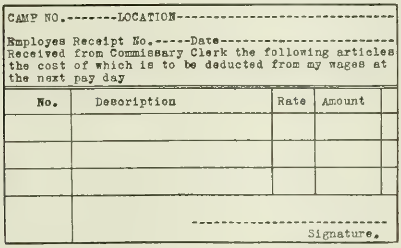


Fig. 2—Layouts of Bunk Houses and Bath House.

The store room and refrigerator should at all times be stocked with a liberal supply of food, but kept well under control for fear of encouraging extravagance or waste on the part of the cook and his helpers. Arrangements should be made for securing fresh meats at stated intervals and fresh vegetables, butter, eggs and milk can usually be provided for locally. Local purchases must be paid for in cash from day to day and a working fund will be required to take care of them. The cook will perhaps prefer to use canned goods almost entirely because of the ease with which they can be prepared for the table, but it is more economical and better for the men to use fresh vegetables when in season.

The bill of fare will need quite a little study and consideration. While it is planned to give each man a sufficient amount of good, plain and substantial food, properly cooked, at each meal, care should be taken not to serve the same thing every day, but to provide the variety necessary to everyone. Many of the complaints made of the food may be traced directly to a lack of variety and not to the quality of the food or the way in which it was prepared. It will be found that most men crave pies, puddings and pastry, and it will be found necessary to use discretion in the matter. A little extra attention to these matters on Sundays and holidays will go a long way toward keeping up a good feeling in the camp.


CAMP NO.-------LOCATION------------------------------

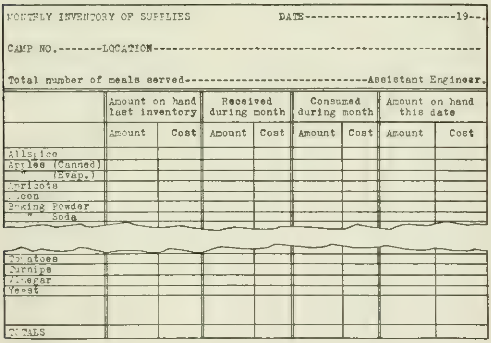
Employes Receipt No.-----Date------------------------
Received from Commissary Clerk the following articles the cost of which is to be deducted from my wages at the next pay day

No.	Description	Rate	Amount	

Signature.

Receipt for Supplies From Commissary.

It is quite generally the custom to provide free meals for the engineer in charge, the commissary clerk, the cook, the flunkies and the camp help, but the practice should not extend beyond that. All others should either pay for their meals in cash or sign orders for deductions from the payrolls. The boarding of transients should be discouraged, but when this is necessary they should pay a higher price per meal than the regular force in order that they may share in the supervision expense which is not covered in the prices charged the workmen.


MONTHLY INVENTORY OF SUPPLIES DATE------------------------19--.

CAMP NO.-------LOCATION--

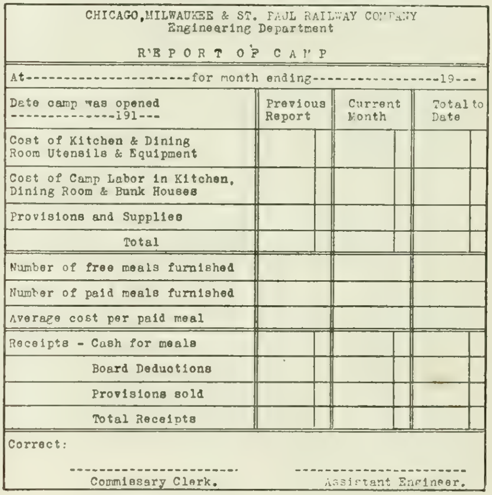
Total number of meals served-----------------------------Assistant Engineer.

	Amount on hand last inventory		Received during month		Consumed during month		Amount on hand this date	
	Amount	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Allspice								
Apples (Canned)								
" (Evap.)								
Apricots								
Bacon								
Baking Powder								
" Soda								
Tomatoes								
Turnips								
Vinegar								
Yeast								
TOTALS								

Report Forms for Monthly Inventory of Supplies.

Meals should be served at regular hours and promptly, and it should be the aim at all times to give the best possible service that conditions will permit. Special attention should at all times be given to cleanliness. Waiters must be instructed to put on clean aprons before each meal. After the meal is finished, the dishes are collected and taken to the sink where they are thoroughly washed with hot water and soap. Many of the minor ailments of men in a camp may be traced to the improper washing of dishes. The floors of the dining room and kitchen must be swept after each meal. The tables are to be scrubbed with soap and hot water after each meal, the dining room twice each week and the kitchen floor every day. After the dishes are washed they are put in place on the tables ready for the next meal, and the whole covered with suitable cloths. Dish cloths and towels are to be thoroughly washed in boiling water after each meal and then dried.

Garbage.—Garbage should not be allowed to accumulate. A barrel having a tight-fitting cover should be provided, and in this all of the garbage is collected. Once a day this barrel should be taken to a considerable distance from the camp and the contents buried, or better still, burned. A garbage incinerator can be constructed easily and cheaply, and it is by far the more desirable plan.


CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY
Engineering Department

REPORT OF CAMP

At----------------------for month ending-----------------19---

Date camp was opened --------------191---	Previous Report	Current Month	Total to Date
Cost of Kitchen & Dining Room Utensils & Equipment			
Cost of Camp Labor in Kitchen, Dining Room & Bunk Houses			
Provisions and Supplies			
Total			
Number of free meals furnished			
Number of paid meals furnished			
Average cost per paid meal			
Receipts - Cash for meals			
Board Deductions			
Provisions sold			
Total Receipts			

Correct:

---------------------- Commissary Clerk.
---------------------- Assistant Engineer.

General Report Form for Camp.

Water Supply.—If a well of good drinking water can be secured, it will be found a wonderful asset to the camp. The well should be located not nearer than 100 ft. from any camp building, and preferably more, and if possible on a rise of ground. It should be curbed at least 1 ft. above the ground level, and the surrounding space filled in with earth to slope away from the well. It should be properly covered and protected so that nothing may be thrown into it that will pollute the water. It goes without saying that outhouses and the disposal of garbage should be kept at a safe distance, not less than 200 ft. away.

Sometimes a good spring is located in the near vicinity and the water can be piped to the camp. Should the camp be so located that water from a river or lake must be used, the problem becomes more serious, and extraordinary precautions must be taken to keep the water from being polluted. Water taken from a lake or river must usually be boiled before it is used for drinking.

Commissary Store.—It is sometimes necessary that a commissary store be run in connection with the camp, especially when the camp is located at some distance from a town. This commissary store is to be in charge of the commissary clerk, and should carry in stock such goods as are most frequently called for and used by the men, such as overalls, shirts, socks, blankets, heavy shoes, overshoes, and standard brands of tobacco. This list may be extended as warranted in the judgment of the engineer, but in no case should it include liquor of any kind.

When a camp and commissary store are run by the railway company, it is not for the purpose of making a profit, but care should be used to see that it is not run at a loss. For that reason careful accounting is necessary, and precautions should be taken to prevent petty thievery or grafting.

A commissary should not be run in competition with a local store. In the first place, the conduct of a commissary is an added care that ought to be avoided if possible, and in the second place, it is the desire of the railroad company to encourage business along its lines. The commissary store should be run on a strictly cash basis.

Accounting.—All accounting in connection with the camp and the commissary store should be as simple as possible, but separate books should be kept for each in order that any profit and loss may be allocated to the right source. Two books for each will suffice, one a combined daybook and journal in which all transactions are recorded, and which at the end of the month will show the total debits and credits, and the order a cash book which records the case transactions only, and should be balanced each night with the amount of case on hand. In the daybook-journal for the camp, the debit entries consist of kitchen utensils and supplies, fuel, oil, food supplies, and wages of camp employes. This account begins each month with the inventory of supplies on hand. On the credit side will be entered the board of the men, receipts for supplies sold and the inventory of supplies in the store room at the end of the month. The difference between the totals of the debit and credit entries will show whether the camp is being run at a profit or a loss.

Price of Board.—It is quite customary, in determining the price to be charged for board and lodging, to charge the employe what he would have to pay ordinarily in nearby towns and then furnish as good board as possible with a view to having the camp pay for itself. The cost of the meals furnished to those employes needed to operate the camp is considered a part of the camp expense. Should there be any employes on the work whose expenses are paid by the railway company, the cost of the meals should be charged to the work and the camp given credit. At the beginning of the work the force may be comparatively small, and at the close of the work it will gradually diminish, making two periods during which the camp will not pay for itself. It should, therefore, be planned that when the force is at its maximum, the camp should make some profit in order that, when the work is closed, the accounts will about balance. In order to do this the affairs of the camp will have to be planned and watched carefully.

It will be found more satisfactory to use a rate per week than a rate per meal. In the former case the matter of lost meals need not be watched, and there are apt to be fewer misunderstandings. It will also insure a more regular attendance at the camp meals on Sundays and holidays. If a rate per meal is decided upon, some form of meal ticket will have to be provided, which is punched as the men enter the dining room.

As a general experience a camp of 25 men or less will not pay expenses; a camp of from 50 to 75 men can be made to come out about even, and a larger camp will show a slight profit. This bears out the previous statement.

Bunk Houses.—The construction of the bunk house will depend upon the locality and the season during which it is to be used. If in use during the winter, it must be built quite substantially so as to withstand storms and cold. If the bunk house is to be used only for a few months during the summer or in very warm climates, it may be of very light construction, but it should always be so built that it will keep out the rain. It should be built high enough above the ground to enable a man to get under it, and a positive rule should be made that the space underneath be kept clean and that no accumulation of rubbish or old clothes will be allowed.

Bunk houses or sleeping quarters should not be made too large. It is much better to have a number of smaller houses than to endeavor to make one building large enough to provide for the entire force. There are apt to be disturbing factors during the night, such as someone being taken sick or other unusual occurrences, which will disturb the entire camp if all the men are housed in one building. For the common labor, it has been found desirable to have houses that will accommodate from 30 to 40 men each, although some would limit the number to 24. For the housing of sub-foremen, carpenters and other high grade labor, houses accommodating from 12 to 16 men are preferable.

Bunk houses, built rather long and narrow with bunks on either side and a central aisle, appear to be the most satisfactory and have the added advantage that they can be loaded on cars and transported to other jobs. Old car bodies, when available, may also be used. The sketches submitted show various arrangements. In very large camps, it is at times decided to build houses that will accommodate more than 40 men, but because of their size, they are more costly.

It is quite customary to build bunks of wood, but great improvements have been made in the last few years in the manufacture of steel bunks, and they are being installed in many camps because of their greater comfort, and the ease with which they are kept clean and sanitary.

There is one item which at first thought may seem an extravagance, but which will do much to hold the men and that is the installation of individual lockers. Metal lockers may be deemed too expensive, but they are more sanitary. They should be in good condition when the camp is taken down and can be used elsewhere. Wooden lockers with doors having an opening of wire mesh can be easily and cheaply constructed. They should be built in two tiers, 2 ft. square and 4 ft. high, large enough to hold a suit case. Good locks with individual keys should be furnished. Each man is given a key attached to a metal tag bearing the same number as the locker. The key is charged up to him and he is obliged to turn it in when he leaves before receiving his pay. Lost keys are charged to the men and deducted from their pay.

In spite of the utmost precaution there is likely to be trouble from vermin. Men are likely to carry them from other camps in their clothing or in other ways. A rule should, therefore, be made that once a month each bunk house is fumigated. After the men have left for work in the morning, the bedding is all taken out, the mattresses turned up, doors, windows and ventilators closed, and sulphur candles burned. Use twice the dose that is recommended by the manufacturer, because bunk houses cannot be sealed as tightly as rooms in a house. After fumigation the bunk house should be thoroughly aired before it is occupied again.

Camp Man.—The sleeping quarters are kept clean and in order by a camp man, whose duties are to sweep, carry coal and keep the bunks in order. Bunk houses, except in very warm climates, or when used for only a short period during summer months, should always be provided with stoves. Railway caboose stoves are well adapted to that purpose. In cold weather men must have a place to warm up, and in wet weather there is always clothing to be dried out. Sleeping quarters should not be allowed to become damp and musty.

A water barrel should be provided at each end of each camp building for use in case of fire. In the winter time the water should be heavily salted or saturated with some anti-freezing mixture. It should be the camp man's duty to examine each barrel every day, and see that it is filled and ready for use. A pail with a rounded bottom, marked "to be used only in case of fire," should be provided for each barrel.

Night Watchman.—A camp night watchman on duty all night is also a necessity. It should be his duty to see that the lights are put out at the proper time (9 o'clock is a good hour to set), to keep up the fires in winter, and to see that late comers, or those who are inclined to be up late, do not disturb the remainder of the camp. Men will sleep and rest better if they know there is someone on guard to see that they are not disturbed or robbed, and a good night's sleep means better work the next day. The watchman is also there for prompt action in case of sickness, fire or other emergency. It is also his duty to wake the men at the proper time each morning, first the cooks and flunkies, in order that breakfast may be started on time, and then the men, to get them up in time for breakfast and thus start the day right.

Lighting.—When it can be had, electricity is the ideal method of lighting a camp, and it can frequently be supplied without undue cost. The camp may be near a town having a power plant, or near some power line from which current may be obtained. The electric light will do much to insure cleanliness; a temporary installation is not expensive, and it will also materially reduce the fire hazard. On a large piece of work of long duration where power machinery is used, it will pay to install a lighting plant, and especially where the electric current can also be put to other uses.

Where ordinary lamps must be used, they should be kept clean and in good order at all times, and their placing should be so safeguarded that they are not liable to be overturned when being lighted, or knocked over when men are passing back and forth. Bracket lamps fastened to the wall as high as possible and equipped with metal protectors may be used. In many places lanterns will furnish ample light and are safer.

Ventilation.—All camp buildings should be provided with sufficient means for ventilation, even though built in the most temporary manner. This refers particularly to the sleeping quarters. Sufficient fresh air without unnecessary exposure to cold and storms will do much to keep the working force in good condition. Should the dining room become too hot and stuffy during meal time the men will complain, and the matter can be easily remedied, but at night men are apt to sleep in poorly ventilated bunk houses without realizing why they do not feel rested and refreshed in the morning. It should be made the particular business of some one man in each bunk house to see that there is sufficient circulation of air before he retires. All windows should be in condition to open and close readily, and the roof should be provided with ventilators. Proper means of ventilation can be installed easily and inexpensively.

Outhouses.—Outhouses sufficiently ample for the needs of the camp must be provided, be made as convenient as possible, and located at a safe distance (not less than 200 ft.) from any camp building, where the natural drainage of the ground is away from the camp. The usual procedure is to dig one or more sumps, as may be deemed necessary, and erect suitable outbuildings over them. Such buildings should be kept as dark as possible by painting them some dark color and locating them in a group of trees, because flies shun dark places. They should also be screened. Keep them as clean as possible by sweeping them once a day and scrubbing them twice a week. Provide receptacles for paper. Cleanliness and neatness should not only be encouraged, but insisted upon. The excavation for a sump should be quite deep. Once a week the outbuildings should be moved to one side and a layer of chloride of lime and 6 in. of earth placed over the excrement. When the filling nears the surface of the ground the excavation should be entirely filled and a new sump dug in another location. Chemical or waterless toilets may be necessary in some localities.

It is a common experience that it is comparatively easy to get men to comply with rules for sanitation in camps established for long periods, but that they are careless in the small camps established for only a few weeks; therefore strict and definite rules must be laid down and their compliance insisted upon as part of the condition of employment. If the camp is fortunate enough to have a liberal supply of running water so that sanitary closets and a cesspool may be built, these should by all means be provided.

Method of Blasting Channel in Quicksand and Clay

Dynamite cartridges encased in tin tubes were used successfully in blasting a water supply channel in quicksand at one of the plants of the American Brick Co. The channel is 530 ft. long and extends through a tangle of underbrush. The soil is quicksand and clay. In blasting through the clay, a hole was bored and cartridges pushed down with a stick, no tamping being necessary as the water filled the hole.

The strip of quicksand measured about 35 ft. across. For the work tin tubes, the shape of torpedoes and about ½ in. longer than a stick of dynamite, were made. Cartridges were encased in the tin tubes and then pushed down into the quicksand to the required depth.

The charges were spaced about 2 ft. apart both in the quicksand and in the clay. In one hole, the charge consisted of a cartridge and a half of dynamite; the next hole, one cartridge; then a cartridge and a half and so on alternately down the line. The cartridges were put down to a depth of about 2½ ft. The resulting shot gave a ditch about 3 ft. deep and 6 ft. wide.

Methods and Cost of Tree Planting

Reforestation operations in the national forests under the direction of the U. S. Forest Service now cover from 12,000 to 15,000 acres yearly. An interesting description of this work is given in a U. S. Department of Agriculture bulletin prepared by Mr. C. R. Tillotson, Forest Examiner. The following notes on tree planting methods have been abstracted from this bulletin:

Slit Methods.—The slit method consists simply of opening a wedge-shaped crevice in the ground by driving a spade, mattock, or axe into the soil and moving the handle backward and forward or sidewise a little. A hole 2 or 3 in. broad at the top, as wide as the blade of the tool, and tapering to an edge at the bottom is thus formed. Into this crevice the roots of a plant are thrust and shaken down as well as possible. The soil on each side of the hole is then compacted against the roots by means of vigorous tramping and stamping with the foot or by inserting the tool into the soil again on the far side of the plant and prying the soil toward it. Before making the slit the surface soil and sod is scraped away sufficiently to remove debris or dry soil which may fall into the hole when the tool is removed. Further, when the mattock is used, the soil over an area 6 or 8 in. square is ordinarily loosened to the depth of the mattock blade and the cleft is then made in the center of the loosened area.

The principal advantage of this method is that it is rapid, and, where it can be practiced successfully, correspondingly economical. Moreover, it makes possible the covering of large areas during a planting season. On the other hand, it can not be followed to good advantage except in soil which is fairly loose and free from rocks, because it is difficult to make a deep enough cleft in heavy or rocky soil; and, what is still more important, a cleft in such soil can not be properly closed by tramping after the seedling is inserted. Where the cleft is not properly closed air spaces are left around the roots, causing them to dry out; and the death of the plant follows. Further, careless or rapid planters often will not take the trouble to see that the roots are not bent, and that the root tips are not near the surface of the soil where they will soon dry out. Such planting is almost certain to result in failure. The method has been followed successfully, however, particularly on the Nebraska National Forest in the sandhill region, where a crew of two men will average about 2,000 plants per day of 8 hours.

A modification of this method is sometimes called the "grub-hoe method." In this the grub hoe or mattock is driven into the soil to the depth of the blade; the tool is pulled slightly toward the operator; the roots of a plant are thrust into the opening thus formed back of the tool; and the blade is then lifted in such manner that the loosened soil slides off upon the roots of the plant. This soil is then well tramped about the roots. The method is simple, easy to perform, and rapid; and the soil is not scattered. Planting can be carried on at an average of from 600 to 800 trees per man per day, and as many as 1,000 under favorable conditions. On good soils and in regions very favorable to tree growth, as in Washington, Oregon, and western Idaho and Montana, this method has proved very successful. It is not yet known, however, that it will be successful in regions or on sites not particularly favorable to tree growth. The hole opened up is not large enough or deep enough to allow the proper distribution of the roots; it usually does not remove much of the competing herbaceous growth; and it does not permit especial attention being given to the packing of the soil around the roots.

Trencher Method.—The trencher method is simply a modification of the slit method. One of its best features is breaking up heavy sod or herbaceous growth and thus freeing the seedlings from root competition and excessive shading. The field trencher and its use have been described as follows:

The trencher consists of a heavy V-shaped shoe fastened on an ordinary steel plow beam and supplied with handles similar to plow handles. The shoe is 24 in. long, 12 in. deep, and is made V-shaped by riveting plates of steel together at the bottom and separating them 3 in. at the top. These plates are welded and drawn out into a thin sloping edge in front, the lower part of which is widened into a broad nose. The nose draws the shoe into the soil, and a small horizontal plate attached to the bottom of the shoe serves to hold it to an even depth.

With a strong slope from the nose to the top of the shoe in front, roots and trash in the soil that are not severed when the shoe strikes them are inclined to be raised above it and then slide off at one side of the beam without injuring the trench. The length of the shoe is such as to cause the sides of the trench to be sufficiently troweled to make them stand up until the planter comes along to put in the tree. The use of a short shoe results in the trench caving down and half filling in many places almost immediately after the trencher has passed.

The trencher is drawn by three horses, and in its use on the Kansas and Nebraska National Forests the trench is usually made in a furrow turned with a sidehill or ordinary plow. A man with a planting basket follows the trencher and puts trees into the trench, being careful to have the roots well extended toward the bottom. As the crowns of the trees are brought to the proper height, the planter sets his foot at a slight angle to the trench, caving the side in against the roots. Men with long-handled tampers follow, setting the soil firmly against the trees, and close the trench between the trees to reduce the chance of evaporation. A gang of 10 to 15 men is required to keep up with the trencher and can plant from 12,000 to 20,000 trees per day.

On the Kansas National Forest this scheme was brought nearer to perfection by the use of a riding trencher, which combines a lister plow with a trencher and thus saves the expense of one driver and two horses.

Up to the present this method has been followed only on the Kansas and Nebraska National Forests; it has proved rapid on both and successful on the Nebraska. The method, however, is limited in its scope. It can not be followed on very steep hillsides, in soil that is rocky or filled with large roots, or on areas covered with brush or considerable down timber; and it is questionable if it would be successful in very heavy soil. In short, the method is not suitable for the greater proportion of the lands in the West on which forest planting will have to be conducted.

Square or Deep-Hole Method.—A square hole 7 or 8 in. across and about 1 ft. deep is dug, either with a spade or a mattock; and for utility in planting, the soil removed is placed adjacent the hole. Properly the soil removed should be kept in two separate piles; the moister, richer soil of the upper layer in one pile, and the lower subsoil in the other. The depth of the holes depends upon the size of the stock; they should be deep enough so that the roots may hang straight down in their natural position when the tree is set at the same depth as in the nursery. The tree is held by the root stock with the fingers between the different ramifications of the roots so as to spread them apart. This is done with the left hand, while the dirt is filled in with the right. The moist, better soil is first drawn in over the roots and packed well around them with the fist; then the remainder of the soil is thrown in and part of it well packed, a portion lying on top being left loose to serve as a mulch. On slopes, the aim should be to leave the surface of the soil at the same angle as the slope of the planting site instead of leaving a depression in the soil. Where a depression is left, soil from above is apt to wash into it, or leaves may drift in and partly or entirely cover the plant. The drifting in of leaves has caused considerable loss where the planting has been done under a stand of aspen.

This method is the most applicable to all species and sites; it removes part of the competing growth of sod; and it (or a modification of it called "side-hole method") will undoubtedly continue to be the one in most general use in the future. It is only fairly rapid, from 250 to 350 trees per man per day in rough country constituting an average day's planting, and there is the possibility of poor planting if the crew is not careful to spread the roots during the operation.

In the side-hole method the trees are set against one side of the hole instead of in the middle. It is a little more rapid than when the trees are set in the middle of the hole; and, experimentally, in operations on the Siuslaw National Forest and at the Fort Valley Experiment Station, it has proved almost as successful. It cannot be given unqualified indorsement, however, without further trial, though with the ordinary planting crew it will probably prove just as successful in the majority of operations as planting in the center of the hole.

Cone Method.—The cone method is another modification of the square-hole method. The square hole is dug as in the other method; a mound of earth is then built by the planter in the bottom of the hole, and the roots of the plant are spread over this mound. Thus they come in contact with a greater amount of soil, from which moisture and other plant nourishment can be drawn. After spreading the roots, the soil is filled in as in the square-hole method.

This method unquestionably has merit for planting under very unfavorable conditions; for, if it is properly conducted, the losses are usually smaller than where other methods are used. On the other hand, it has disadvantages. It is not applicable to species which do not have a ramifying root system; unless given close supervision, the average workman will not be particular to form a good cone or to spread the roots well over it; and it is slow and expensive. Under average conditions one man will plant only from 200 to 250 trees per day.

Plowing and Mattock Method.—Single furrows are plowed from 8 to 10 ft. apart, and holes are then dug with a mattock to receive the plants. It has been found that just about twice as rapid progress can be made as where no plowing is done, both in digging holes and in planting, because digging is easier in the broken sod and more loose dirt is provided for filling in around the trees.

Like any other method where a plow is used, this is subject to limitations; but on account of its rapidity and the success which has attended its use, it is worthy of trial, particularly in grassy or sagebrush land where the plow can be used. On steep, grassy sidehill areas open to grazing by cattle there is a serious drawback to this plan; the animals follow the furrows as paths and are likely to tramp out a large proportion of the planted stock.

Pit Method.—The pit method is designed particularly for use in regions which, following the planting season, become particularly hot and dry. It has been used by the Forest Service mostly in fall planting in southern California. It consists in partially preparing the holes in advance of the planting operations. Spots are cleared about 16 in. square and the surface soil stirred to a depth of about 8 in. Then in a spot about 8 in. square in the center the soil is removed to a depth of from 12 to 16 in. in order to loosen it up thoroughly. It is then replaced and a depression left on top. Where the original method is adhered to, the work is finished a month or more before the time of planting.

Rain which will saturate the hard ground only to a depth of 2 or 3 in. will be sufficient to penetrate from 12 to 16 in. in the soft soil of the pits. This is one of the most important points in their favor. Soil when moist to a depth of 12 in. is suitable for planting. Thus, when the contiguous land is not ready for planting and may not be for some time, the soil in the

TABLE 1—COST PER ACRE AND PER 1,000 TREES OF PLANTING DIFFERENT SPECIES IN DIFFERENT REGIONS BY VARIOUS METHODS.

Region.	Species.	Method.	Cast per acre.	Cost per 1,000 trees.
Southern Montana	Douglas fir	Spade hole	$15.01	$12.40
Southern Montana	Douglas fir	Spade hole	15.58	12.88
Southwestern Montana	Western yellow pine	Mattock holes	4.61	9.53
Southwestern Montana	Western larch	Ax, slit method	7.45	13.85
Southwestern Montana	Western yellow pine	Ax, slit method	3.36	6.94
Southwestern Montana	Western yellow pine	Ax, slit method	10.04	16.60
Southwestern Montana	Western larch	Ax, slit method	10.22	18.77
Central Montana	Douglas fir	Pick holes	12.15	15.62
Southern Montana	Douglas fir	Mattock holes	9.71	12.63
Southern Montana	Douglas fir	Mattock holes	5.10	7.01
Western Montana	Western yellow pine	Mattock holes	9.97	12.93
Western Montana	Engelmann spruce	Ax, slit method	5.10	7.55
Western Montana	Engelmann spruce	Mattock holes	7.15	9.41
Southern Montana	Lodgepole pine	Mattock holes	15.25	10.00
Southern Montana	Douglas fir	Mattock holes, slit method	4.08	8.16
Central Montana	Western yellow pine	Pick, slit method	7.04	10.35
Central Montana	Western yellow pine	Pick, slit method	5.35	7.87
Southern Montana	Douglas fir	Mattock holes in plowed furrows	16.16	8.40
Nebraska	Jack pine	Field trenches	9.61	7.69
Nebraska	Western yellow pine	Field trenches	15.41	9.78
Nebraska	Western yellow pine	Field trenches	10.09	6.40
Southern Idaho	Douglas fir	Mattock holes	11.39	11.39
Central Utah	Douglas fir	Mattock holes	12.77	12.77
Southern Idaho	Douglas fir	Mattock holes	14.05	11.67
Southern California	Jeffrey pine	Mattock holes	16.70	16.70
Northern California	Western yellow pine	Mattock holes	19.10	27.28
Northern Oregon	Douglas fir	Mattock holes	8.25	12.20
Northern Washington	Douglas fir	Mattock holes	8.78	12.91

pits is moist enough to make planting feasible, so that operations may be finished before the advent of cold weather. The plants will then have a better opportunity to become partially established during the fall.

Pot Planting.—Sometimes stock which has been grown in paper pots is planted. The whole pot is planted either in a hole or a pit. The pot is set in the hole and the loose soil thrown in and firmed closely around it and piled up enough to cover its top.

Pot planting is particularly designed for arid and semiarid regions or for summer planting. The roots are not disturbed or exposed during the operation, and good soil is retained around them. This is decidedly conducive to success, particularly in dry regions.

Ball Method.—The ball method consists in removing each tree from the nursery with a ball of the nursery soil surrounding the roots and planting it in the field in this condition. Almost the same advantages would result from this as from pot planting, but it is obviously impracticable thus to remove the small trees used in forest planting.

Cost of Planting.—The actual cost of a number of representative Forest Service operations is shown in Table I.

For the greater proportion of reforestation operations conducted on a large scale, the cost of direct seeding can be kept within from $4 to $6 and planting within $10 per acre, provided a spacing of 8 by 8 ft. is followed. Under more favorable conditions these operations have been carried on at a lower cost.

Motor from Old Automobile Furnishes Power for Hoist

The home-made power plant, illustrated below, gave good service in driving piles in connection with the construction of 14-ft. by 18-ft. concrete slab bridges for Iowa County, Iowa. A 4-cylinder Moline gas motor was taken from an old automobile and geared to a single drum hoist which operated the pile driver. With this arrangement about three 16-ft. piles were put down per hour. M. O. Burnett, Marengo, Ia., was the contractor.

Old 4-Cylinder Gas Motor Operating Hoist.

Construction Camp Regulations of Alaskan Railway Commission

Construction camps shall be located on the best site obtainable, from the standpoint of water supply, drainage and sewage disposal, consistent with convenience to work.

When the water supply is to be taken from a stream the point of intake shall be above the camp site, and a sanitary survey of such stream above such intake shall be made to ascertain if there be any source of pollution. If there be a source of pollution of such stream such fact, with all available data, must be reported at once to the sanitary officer of the division, by the district engineer, and a well dug to conform to the following regulations:

No well may be located at less than 100 ft. from any cesspool, toilet or stable, and must not be on ground receiving drainage from any such place.

All wells supplied with pumps must be curbed up to a point one foot above the surface of the ground and tightly covered.

All wells supplied with ropes and buckets must be curbed up to a point 30 in. above the surface of the ground, and fitted with a good cover.

All wells must be backfilled with earth or gravel around the curb to a depth of 1 ft. at the curb, sloping to the surface of the ground 6 ft. away from such curb, in order that surface water cannot get into the well.

The cook tent must be located on sloping ground or that which can be drained easily. The floor of such a cook tent shall be of dressed lumber, preferably tongue and grooved flooring, water-tight; if not water-tight, such floor shall be raised 12 in. above the surface of the ground so as to permit free circulation of air underneath; must be scrubbed daily and kept in a clean and sanitary condition at all times.

All fixtures and utensils must be so arranged as to permit of free access for cleaning purposes.

All work tables and other utensils must be kept free from accumulations, such as flour, dough, grease, etc.

All canned goods, excepting milk, must be emptied as soon as opened, and not permitted to stand in original tin cans.

All garbage should be burned in the cook stove as completely as possible.

Suitable fly-proof water-tight cans must be provided into which all scraps, empty cans, and waste material shall be placed, which cans shall be removed to a point remote from camp, and the contents either buried or burned. Such removal should be made every second day from May to September inclusive, and once a week during other months. Throwing such garbage in streams will not be permitted.

A well ventilated, properly screened fly-proof meat house shall be provided adjacent to the cook tent, for storing small quantities of fresh meat. On receipt of any fresh meat in bad condition, from any cause whatever, such fact, with full data, must be reported at once to the district engineer, who will report same to the sanitary officer at Anchorage.

The mess or dining tent shall be separated from the cook tent or kitchen by a door or fly that may be closed.

Tables shall be provided with cotton fly-screen, which shall be kept spread over the tables except when they are being used to serve meals. Mess tents shall be kept free from flies as possible, and suitable measures must be taken to secure such results.

The Contractor's Superintendent*

When a contractor secures more work than he can handle personally, it becomes necessary for him to employ some one to manage at least part of it. This employe is ordinarily called a superintendent. His duty is to represent the contractor in the management of the work and in his dealings with the principal or client. The authority he may have in any case depends upon the people he is working for and upon himself. He may, in reality, represent the contractor, both in the management of the contract and in his dealings with the client and others. For all practical purposes he is the contractor, managing the work in all its details, and being responsible for results only. In this case the general policy would be laid down by the contractor, and the plant to be used and its lay-out would be settled in conference with the contractor. The superintendent would deal directly with the client and would settle minor matters without reference to the employer. Even in this case the superintendent is necessarily guided by the general policy of the company, especially where it affects other contracts which the company may have. In other cases the superintendent may be required to refer every little detail to his employer, either because he is not big enough to have greater responsibility placed upon him or because the employer himself desires to handle all details. The ideal case is one in which the superintendent is big enough and competent enough to manage and is responsible only for results.

Under our plan of organization we place a superintendent on each contract. If the work is all in one location and of sufficient size, the superintendent usually has a general foreman on whom the details of the management fall and to whom the various foremen report. If the work is scattered, there may be one or more assistant superintendents, or in the case of grading work, what is known as a walking-boss. All clerical work is handled by the superintendent's clerk who has such assistants as he requires. To him the timekeepers, material men, and commissary clerks report. When the contract is of sufficient magnitude, an engineer is assigned to the superintendent. His duties are to measure and keep track of the work done and make any plans or calculations which may be required. He might, for instance, be called upon to make a plan of a pile driver, or design sectional concrete forms, or sketch the layout of the plant. He is expected to check with the client's inspectors and engineers to make sure that our work is correctly measured and classified. A position of this kind offers excellent training for that of superintendent. You will notice that this organization is practically the same as if the superintendent were a contractor with only one job.

To give you an idea of the superintent's duties we will follow through the operation of an imaginary contract. The first thing to be done is to prepare the bid for the work on which we have been asked to make a proposal. In order to learn the local conditions we first have one or more of our superintendents investigate the proposed work on the ground. They examine the foundation sites, the material to be excavated, and the location of sand and gravel pits; determine the available local supply of all other materials, and look up the roads from the nearest railroad over which material may be hauled, the local supply of labor, and the prices to be paid for both labor and material. A study is made at the site, of the method of handling the work and the plant required. After finishing the local study they investigate other points from which materials may be obtained and determine what the material from such points will cost.

After these investigations have been made, the next step is to make an estimate of the unit cost of each item in the contract. This estimate is based on the cost of labor and material for each item, plus a proportion of the general expense. The term "general expense" includes items of expense not covered by labor and material, such as superintendence, liability insurance, bond, depreciation of plant, small tools, supplies, fuel, traveling expenses, buildings, loss on camps, and innumerable other items. Costs should be based upon records of similar work, adjusted by judgment to fit the work in hand. After the men have prepared their estimates of costs, a consultation is held and their figures are subjected to a critical analysis each item being considered in detail. There are often wide variations in ideas regarding costs, which must be thrashed out and reconciled. When the revised estimate of cost is finally agreed upon, it ordinarily represents the combined judgment of three or more men. The margin of profit desired is now added and the bid made up and presented to the prospective client.

If the proposal is attractive and the work is awarded to us, a superintendent is assigned to the contract and his job of organizing begins. A general foreman, experienced in that particular line of work, and a clerk, are detailed from our organization. Then formen, timekeepers, and the rest of the organization are selected. In the meantime, in consultation with our office, the method of handling the work is fixed, the plant required is determined upon, and the assembling of the same is started. The successful outcome of the contract depends to a large extent upon the proper selection of the plant and the proper lay-out of the work. For instance, if grading is under consideration, is it steam shovel, drag-line, or team work? If shovel work, how large a shovel and what size of cars are to be used? Does the work require standard gage equipment with heavy locomotives and 12, 16 or even 24-yd. cars; or, are smaller cars with narrow gage "dinkies" best? And so each detail must be decided upon. If concrete work is under consideration, the type of distributing system must be decided; whether the chuting system will be employed or whether the concrete will be distributed by cars or by buckets handled by derricks. Then the mixing plant with charging-hoppers and other details must all be worked out. Any new plant required is bought and that which we have in stock is loaded and shipped to the work. It may come from other contracts where it is not needed or from a storehouse. In the meantime arrangements for materials have been made. On securing a contract, we ordinarily protect ourselves as far as possible by closing for all of the material required during the life of the contract.

The superintendent, with a nucleus of his force, gets on the job, picks his camp site, builds camps, puts his roads in shape, gets the material, plant, and organization coming, and starts work. The selection of a camp site is an important matter, depending upon the lay of the land, water supply, accessibility, and many other considerations. With the help of the general foreman the organization is licked into shape. It is now up to the superintendent to keep his eye on the job and keep it lined up. He must so organize and handle the work that every one pulls together, so that it goes along with a swing. Of course this is impossible unless he plans each operation in advance and every foreman or straw-boss knows before he is up against it just what he is going to do next. It is possible on going onto a job, to feel that everything is going along swimmingly or that the work is disorganized. Just as one riding in an automobile can tell whether every cylinder is working or whether one or more of the cylinders are missing, so you can tell whether or not the force is hitting it up well.

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*From an address by W. A. Rogers, President Bates & Rogers Construction Co., Chicago, Ill., delivered before the College of Engineering, University of Wisconsin.

As soon as possible after getting started, it is our plan to have the superintendent make out a schedule showing the dates upon which he plans to start and finish each operation. For instance, if he is building the substructure of a bridge, he estimates the date of starting and finishing the excavation for each pier or abutment; when he will build each cofferdam; start and finish pumping; start and finish driving piles; and start and finish the concrete. This schedule is made up with the idea of completing the work well ahead of the completion date named in the contract. The dates are revised from time to time as the work progresses. There are many advantages in having this schedule. In the first place, it means that the man in charge, in order to make it up, must necessarily plan the job through in all its details. He has before him at all times, a schedule of what is to be done next and it keeps him prepared for the next move. Then, too, his organization will have a pride in keeping up with or beating, the schedule. It acts as a pacemaker for the men on the job. It serves as guide by which the main office can check the progress of the work from time to time.

As the job progresses the superintendent is constantly in touch with the client. In addition to handling his actual work he must see that the engineers furnish him plans and instructions, and make their decisions far enough in advance that he can properly arrange for each operation. He must keep everlastingly after the engineers to have them prepare for the work, or he runs the risk of being tied up. Engineers often do not realize the importance of giving instructions as far in advance as possible to that the contractor may look ahead in his preparations. The superintendent, or his assistants, must constantly keep after the delivery of material required. There is rarely a good excuse for getting out of material.

A good superintendent has constantly in mind two things. First, in order that the contractor shall stay in business, he must turn out good honest work, and make friends of the clients by doing a first-class job and completing it on time. In other words, quality of output should be his first consideration. He may occasionally have to restrain over-zealoous foremen who have the idea that it is to the advantage of his employer to skin the work. Secondly, the good superintendent must also remember that, in addition to turning out a first-class job, he must do so at a profit, or his work is not a success. To do this he must be everlastingly after the loose ends, watching for improvements of methods and for economy of materials and supplies. He must look out for close buying, cut out unnecessary work, and in every way lessen the cost of construction. With this in mind, he should know at all times what his work is costing. He should keep, from day to day, the costs of the different units in order that he may know at all times how these costs are running. He must be able to put his finger on any trouble before it is too late. Each man naturally will work out just how he can best handle this personal cost check. These data would be more in detail than that required by the general office.

During the progress of the work a diary, or log of progress, and running history of the work should be kept. This should cover a record of any orders or instructions that have been given. This record is important as history to settle any disagreements which may arise. Each day's notes should be initialled by the superintendent or by the person involved in any occurrence of importance. When the contract is completed the final estimate is checked, and any adjustments of matters which may have been held open until the end are taken up and settled.

How are men trained for this responsible position? We believe the best way is to train the men inside the organization—from the bottom up. Starting at the bottom, the man becomes familiar with the duties of the men in the various steps of progress upward; he becomes saturated with the ideals of the company and becomes familiar with its particular methods of handling the work and system of cost records; he gets to know the men.

He may start as a timekeeper, or commissary clerk, as material man, or even as a laborer, rising through the position of engineer on the work, or through foremanship, or through a clerkship in the office. It is largely a question of the qualifications and capabilities of the man as to just the line he takes. The things which go to make a successful superintendent are largely the same as those which make a successful contractor. These qualifications are both business and moral. He must be a good executive, able to judge men, able to place his forces so that each man is in the position for which he is best adapted. After organizing his force, he must be able so to inspire the loyalty of his men as to get the best out of them that they are capable of giving. His men will not be loyal unless he treats them fairly. I do not mean by this that he must be easy; an easy boss is never respected. He should know what a day's work is and be able to get it out of his men.

The good superintendent will take good care of his men and will furnish a good camp and substantial food. He cannot expect good work unless his men are well cared for. A good business head is a prime necessity. He will deal with all kinds of men, and he must have the business instinct so developed that he can see quickly whether any particular act will pay as a business proposition. He must have ever before him the thought that he is there to make a profit for his employer.

Practical engineering sense well developed is a valuable trait; and while theoretical engineering knowledge is a good thing, what is really wanted is what I would call common sense or practical engineering knowledge. What I mean is that in addition to knowing why a thing is done or how to figure it out theoretically, he must know how to do it right at the least cost; that is, how to construct economically what another man has designed. A detailed knowledge of the various pieces of machinery employed on the work is a fine thing, and the abilty to operate any part of the plant if it becomes necessary, is very valuable. The man who can run a hoisting engine has an important acquisition. The good superintendent must be able to make decisions promptly and be quick to act in an emergency.

Many emergencies arise when the superintendent must know what to do "right off the bat." I often think that the superintendent's training should fit him to be a diplomat, for he surely must use diplomacy in his dealings with his men as well as in the dealings with the engineer and client. The faculty of being able to get along with people is one that has definite value in money. It costs money to be constantly at variance with those for whom one is doing work. The habit of looking at things from the other fellow's standpoint as well as your own is a good habit to form. The other fellow, in the majority of cases, intends to treat you right. What should be done is to get him to see things from your point of view. If you make him angry, it is almost impossible to accomplish this. It may be very exasperating to have a young engineer, just out of school, full of theoretical knowledge but without experience, lay down the law and try to tell the experienced superintendent, who is conscientiously working for the employer, what to do. But it is the business of the superintendent patiently to train the young engineer in practical work, to make him understand that both working for the same end and that the best results are obtained by working together rather than at cross-purposes.

A truly successful superintendent must be a man of good habits, of good moral character, and have high ideals. He must realize that honesty is not only the best policy, but is right, and that it pays to have the reputation of doing honest work. The old idea that a contractor, in order to be successful, must be what is known as a good fellow, inclined to drink, and do other things that he should not, in order to entertain the engineers and others, is obsolete. Any amount of drinking with a man or entertaining him will not help in attaining success; but, on the other hand, may have just opposite effect.

A good address is a valuable asset. While appearances are only on the surface, sometimes the first impression made by the outward appearance is of vital important. If practicable the ability to express one's ideas clearly and forcibly in good language is invaluable. It is a sad fact that many of our college graduates cannot spell correctly. The longer I live the more I am impressed with the importance of being able to talk convincingly on your feet, an accomplishment which I never acquired. The ability to go on a job and take it all in is also important. The habit of observation should be cultivated. Loyalty to the employer is, of course, essential. The man who does not have this quality is in the same class as he who receives money under false pretense, and has the making of a Benedict Arnold. If you are not in sympathy with the people you work for, you should get out. I believe that the superintendent should be constantly striving to widen his acquaintance with engineers, contractors and others with whom his company may later have business relations. He must always keep his eyes open to see how the other fellow does his work, ever ready to select better methods than those he is using. In doing this, he broadens his viewpoint and becomes a better engineer.

I have left to the last, two of the most important qualifications without which I believe it is impossible to become successful. The first is the willingness to assume responsibility. It is far better to do something and do it wrong than to do nothing. The man who is always waiting for some one to tell him what to do and how to do it, does not get anywhere. Take responsibility and put all that there is in you to do right what you have assumed to do. The other qualification is what I call "stick-to-itiveness." The quitter should never enter the contracting game for there is no place for him in it. What is wanted is the man who does the thing he starts out to do, in spite of good reasons why it can not be done; who does not know when he is beaten; who does not know how to quit. If there is a "yellow streak" or quitting streak in a man, he should never start in a career leading to that of a contractor's superintendent. We have in our organization men who when they set out to do a task, do it. We simply forget that it is to be done and assume that it is as good as done when it is turned over to them. That is the kind of man wanted as superintendent and that kind of a man is bound to succeed.

The Fuel Value of Wood

In view of the present coal shortage it is possible that some contractors may have to use wood as fuel for their power units on minor construction jobs. According to the U. S. Forest Service 2 lb. of seasoned wood have a fuel value approximately equal to 1 lb. of coal. While different kinds of wood have different fuel values, in general, the greater the dry weight of a non-resinous wood, the more heat it will give out when burned.

For such species as hickory, oak, beech, birch, hard maple, ash, locust, longleaf pine or cherry, which have comparatively high fuel values, one cord, weighing about 4,000 lb., is required to equal one ton of coal. It takes 1½ cords of shortleaf pine, hemlock, red gum, Douglas fir, sycamore, or soft maple, which weighs about 3,000 lb. a cord, to equal a ton of coal, while for cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce and white pine, two cords, weighing about 2,000 lb. each, are required.

Weight for weight, however, there is very little difference between various species. Resin affords about twice as much heat as wood, so that resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of course, with the resin content.

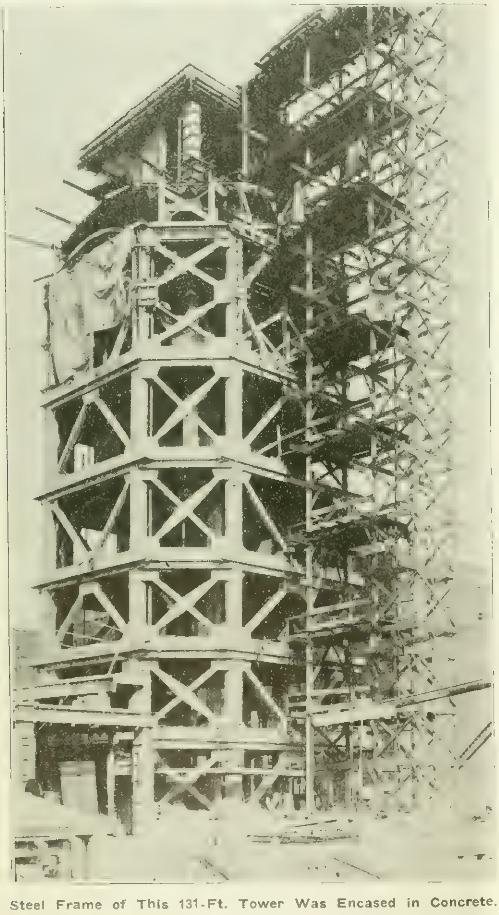
The available heat value of a cord of wood depends also on the amount of moisture present. When the wood is green part of the heat which it is capable of yielding is taken up in evaporating the water. The greater amount of water in the wood the more heat is lost. Furthermore, cords vary as to the amount of solid wood they contain, even when they are of the standard dimension and occupy 128 cu. ft. of space. A certain proportion of this space is made up of air spaces between the sticks, and this air space may be considerable in a cord of twisted, crooked, and knotty sticks. Out of the 128 cu. ft., a fair average of solid wood is about 80 cu. ft. This, however, applies to the standard cord, in which the sticks are cut to 4-ft. lengths and piled 4 ft. high and 8 ft. long. Instead of buying the 4-ft. lengths, however, the sticks are usually cut into 2-ft. lengths by a gasoline saw. This results in a saving of both time and labor. The purchaser should, however, take care to see that he gets full measurement when wood is bought in this way. In parts of New England a stack of 16-in. wood 4 ft. high and 8 ft. long is commonly sold as a "run," but contains only one-third of a cord.

Each section of the country has its favored woods and these are said to be, in general, the right ones to use. Hickory, of the non-resinous woods, has the highest fuel value per unit volume of wood, and has other advantages. It burns evenly and holds the heat.

Encasing Steel Frame of 131 ft. Tower in Concrete

Unusual and elaborate form construction was required for placing the concrete fireproofing of the steel-frame clock tower of the large freight station now being built at Chicago for the Pennsylvania Lines.

The tower has a height of 131 ft. 3 in. above the main building and is divided into eight floors; seven being octagonal in plan and one square with a pyramidal roof. Between the fourth and fifth floors will be a 50,000-gal. sprinkler service tank, and above the sixth floor will be the clock with four 16-ft. dials.



Steel Frame of This 131-Ft. Tower Was Encased in Concrete.

The floors have 4½-in. concrete slabs and all the girders, framing and columns are encased in concrete. In compliance with the city ordinance these members have to be completely enclosed by at least 2 in. of concrete A separate form had to be built around each member and the concrete worked in, almost like grout, around the steel and wire meshing.

As the picture indicates, the concrete was hoisted by a tower. The mixing was performed by a portable car plant described in Engineering and Contracting, Oct. 24, 1917. This plant was moved to a location near the base of the tower and discharged the concrete into wheelbarrows which were hoisted three at a time and poured directly into the forms. Most tedious of all was the concreting of the pyramidal roof where 4½-in. trangular reinforced concrete slabs had to be cast between the roof girders.

When finished in light-red pressed brick with green terra cotta trimmings and a roof of green tile, this tower will be the conspicuous architectural feature of the station.

Strange Freak of Dynamite

By J. B. STONEKING, M.E.

Recently, while sinking a new shaft on the property of the Land Lead Mining Co. at Joplin, Mo., a peculiar incident occurred which illustrates the enormous power of dynamite, the peculiarities of rock cleavage and breakage lines, and the effect of air resistance on a rapidly whirling body.

A 5⅝-in. well drill prospect hole had been sunk previously to locate the ore bodies, and a shaft 5 ft. by 7 ft. begun, using the well drill hole as a center line. When the bottom of the shaft was 75 ft. below ground surface in solid hard limestone, the incident mentioned occurred. The cut holes, eight in number and 5 ft. deep, were arranged to blast out the center cut to relieve the burden on the rib or "squaring up" holes to be drilled later. These eight cut holes were each loaded with four cartridges of 1¼-in. x 8-in. Red Cross gelatin of 40 per cent strength and a No. 6 electric blasting cap, making a total of 32 cartridges.

The eight holes were fired simultaneously with an electric blasting machine, and the force of the blast threw a large boulder from the bottom to a height 100 ft. above the top of the shaft. The boulder fell 50 ft. away from the center of the shaft on top of the mine car track leading to the dump, breaking and bending it out of shape. This boulder when measured was 1½ ft. thick, 3 ft. wide and 4 ft. 6 in. long, but was somewhat irregular in shape and was estimated to contain about 16 cu. ft. A conservative estimate for the weight of this class of stone is 165 lb. per cubic foot, which would make the total weight of the boulder approximately 2,600 lb.

A peculiar feature of this blast is that although there was a large hole, 5⅝ in. in diameter in the center, the rock did not disrupt or break along an imaginary line drawn through this center hole, which might be theoretically taken as the weakest part. This boulder came out and landed with the well drill hole intact through the 18 in. of thickness, and not even a crack was found radiating outward from the center.

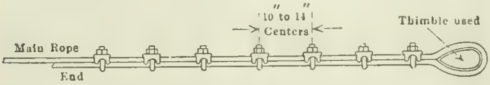
Another peculiar feature of this boulder's freak performance was that it rose to the top of the flight without any twisting or whirling, but at the start of its descent it began whirling rapidly, and this whirling action caused it to curve outward and land 50 ft. away from the shaft.

Since the boulder did not strike the sides of the shaft in the upward course, as evidenced by its not whirling, the line was practically perpendicular, or, at the maximum, a very slight angle from the vertical. Taking the maximum angle which would allow the boulder to clear the collar of the shaft without touching, the point at which it would have struck the ground should be 20 ft. from the shaft.

Notes on the Performance of Hoisting Ropes

The hoisting ropes at the mines of the New Jersey Zinc Co. at Franklin, N. J., are 1⅛ in. diameter, plow steel, 6 by 19 regular lay and 6 by 7 long lay. They support a skip weighing empty about 2¾ tons, with an average ore load of about 6 tons and average weight of "rope out" of about 1,000 ft. or 1 ton. They are wound over 10-ft. diameter drums and 12-ft. diameter head sheaves, and are supported in the shaft by 9-in. diameter idler pulleys spaced 30 ft. apart on the shaft slope of 47° 30′. Each rope is 2,000 ft. long. Interesting data for the performance of these hoisting ropes are given in a 100-page paper describing the mining operations prepared by Mr. C. M. Height and O. F. Tillson for presentation at the St. Louis meeting of the American Institute of Mining Engineers. The following notes are taken from the above paper:

The hoisting ropes are examined each day before regular hoisting starts, and at this time the rope is run very slowly past the inspectors, who look for broken wire or other signs of weakness. A lubricant is used on the rope, but it is such that it does not coat the rope so that the wires cannot be seen. The rope is attached to the bale of the skip with a thimble and clevis, not with a socket. Seven clamps (see Fig. 1) are used to fasten the rope and these are all so placed on the rope that the U-bolt part of the clamp bears on the turned up end of the rope and the broader piece bears on the main rope.



U-Bolts on Side of Loose End – Main Rope has the Part of Clamp with Greater Bearing Surface

Fig. 1.

Tests have indicated that this method of attachment permits the support of a load equal to the ultimate strength of the rope, but when the rope clamps are alternated the rope may fail at 80 per cent or less of its normal strength because of the concentration of stresses where the U-bolt constricts the standing portion of the rope. Experience with various types of ropes has given results favoring a plow-steel Lang-lay rope of 6 strands and 7 wires per strand for use where the sheave wheels and hoist drums are of sufficient diameter to avoid excessive bending (in this case 12 ft. [3.66 m.] and 10 ft. [3.04 m.] respectively), since a greater reduction of diameter by wear may be suffered without fracture of the wires. This wearing service is, of course, more important in a slope shaft than a vertical one. With the regular lay ropes first installed, the type selected had a special arrangement of large wires at the outside of each strand (known as Seale patent lay) and this type of rope gave good service. Ropes with Seale's patent lay of wires have also been tried in the Lang-lay type, but they increased in diameter at various points with a loosening of the outer wires (or "bird-caging") so the stress was carried largely by the few inner wires. This condition was undoubtedly aggravated by the fact that the hoist drums will not hold all the rope in one layer so there is a beating or slapping effect as the second layer is guided over the first layer. "Bird-caging" is also more severe when a swivel attachment of a 6x19 Lang-lay rope is made to the bale of the skip because the twists of both the wires in the strands and the strands of the rope are in the same direction of rotation. Therefore, as the rope is stretched the pitch of the strands becomes greater, and the wires in the strands are untwisted a certain amount. The outer wires of the strands are lengthened in this manner disproportionately with the inner wires and "bird-caging" is the result. If there are only seven wires in the strand there is only one layer about the core wire, so the above effect is not produced. With a regular-lay rope a swivel is an advantage as it permits the rope to rotate as its length changes, and, since the wires in the strand are twisted in the "opposite hand" to the twist of the strands of the rope, they tend to counteract the untwisting of the rope and their outer wires are made tighter. As a result of the excellent manner in which it is standing up under severe service, the 6x7 Lang-lay ropes are preferred in slope shafts provided with well proportioned head-sheaves and hoist drums.

Table I gives a record of service of various types of rope with the corresponding foot-tons of work performed. These ropes were taken out of service when the appearance of a number of broken wires in proximity made this safety precaution appear advisable.

The records of the Bridge Builders and Structural Society, as collected by its secretary, show that during the month of October, 1917, 61½ per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

The Italian State Railways has started construction on a hydro-electric station at Bardonecchia (Susa), a town in the Cottian Alps, 5 miles from the French frontier on the Modane line. The cost of this plant will be about $4,000,000.

TABLE I—RECORD OF HOISTING ROPES IN PALMER SHAFT

Type of rope.	Period in service.	Tons ore hoisted.	Foot-tons of work performed.	Remarks
6 by 19, Seale patent, ordinary-lay, South rope	April 27, 1910, to Feb. 8, 1912, or 650 days	315,759	471,758,554	A
North rope (above plus)	Nov. 4, 1913, to Sept. 20, 1914, or 320 days	200,864	326,441,347	B
Total North rope	970 days	516,623	798,199,901	
6 by 19, Seale patent, Lang-lay South rope	Feb. 8, 1912, to Nov. 4, 1913, or 634 days	408,867	651,957,881	C
North rope	Feb. 8, 1912, to Sept. 20, 1914, or 954 days	609,732	978,399,228	D
6 by 7, Lang-lay, each rope North and South the same	Sept. 20, 1914, to June 1, 1917, or 983 days, and still in service June 28, 1917.	955,470	1,468,287,514	E

Remarks.—Foot-tons of work does not include weight of skip empty and rope when lowering. The above figures should be increased approximately 38 per cent to cover this item.

A. North and South ropes taken out of service because of the number of places broken wires showed; the maximum number of broken wires within one foot was 12.

B. North rope returned to service as an emergency after Lang-lay 6x19 North rope became badly "bird-caged" and had a number of broken wires in one strand ravelling, since breaking tests of sample gave confidence in the rope.

C. Lang-lay South rope removed for reason given in remark "B." It was turned end for end on April 4, 1913.

D. Lang-lay 6x19 North rope "bird-caged" considerably after it was in service a short time, but had few breaks of wires until Sept. 20, 1914, when there were possibly 16 breaks in three feet.

E. Lang-lay 6x7 North and South ropes were turned end for end on July 6, 1916, as a matter of policy, but show not more than four broken wires each at present, and these are now wrapped on the drum. The North rope has suffered severe stresses twice because of skip derailments during hoisting. They appear in excellent condition.

The Work of U. S. Army Engineer Corps Since War Began

The Corps of Engineers of the Army since April 6 has not only been supplying the engineer equipment for an army of 1,000,000 men, but has undertaken the unprecedented task of furnishing railroads complete from the United States for operation in France.

The engineers construct the free arteries through which flow great armies, reinforcements, supplies, and ammunition to the extremities of the lines.

From March 1 to Nov. 1 the Corps of Engineers increased its personnel from 256 officers on the active list to 394 officers and 14 retired officers on active duty and in addition has commissioned more than 5,000 reserve officers. The enlisted force has expanded from 2,100 to 95,000, and there has also been a heavy increase in civilian employes.

In addition, nine railroad regiments and one forestry regiment have been raised as part of the National Army. Seventeen pioneer regiments have been authorized as part of the National Army and are rapidly organizing. National Guard units, equivalent to about seven regiments, have been called into the Federal service, and their reorganization into 17 pioneer Engineer regiments for the 17th divisions of National Guard troops is well under way.

Engineer officers' training camps were established in each of the 16 training camp areas, the number of candidates for Engineer commissions taken from each camp being 150. After a month's training in the same camps with candidates for commissions in other branches of the service the Engineer sections were transferred to three Engineer training camps with special facilities for technical instruction, one in the vicinity of Washington, one at Fort Leavenworth, Kas., and one at Vancouver Barracks. Washington, Instruction was continued there for two months. In August, 1,900 candidates were graduated and are now holding commissions.

Large numbers of engineer graduates of training camps have been assigned to new regiments and special units are being organized and the training of enlisted men in the National Army will be largely under their supervision. A number are in France for special training.

On Dec. 1 about 1,200 Engineer Reserve officers will be graduated from a second Engineer officer's training camp.

A duty imposed upon the engineers has been the purchase of the necessary engineer equipment for more than 1,000,000 men. The urgent deficiencies act approved June 15, 1917, appropriated for the purpose amounts aggregating in excess of $130,000,000, an amount comparable with the purchase of material, equipment, and supplies for the Panama Canal during the 10 years of its construction. The urgent deficiencies act approved Oct. 6, 1917, provides $198,100,000 additional for engineering purposes and it is expected that all of this will be expended during the present fiscal year.

Within 350 hours after the Engineer Corps. following the declaration of war, advertised for equipment, awards had been made covering the requirements of 1,000,000 men, a total of 8,700,000 articles, which included among other items 4 miles of pontoon bridge. Approximately two months was the average time of delivery secured on all of this material.

On Sept. 7, two weeks after receipt of instructions, equipment was en route to the various National Guard and National Army organizations at cantonments throughout the country. These shipments comprised a total of about 48,000,000 lb. in some 64,000 separate cases and packages.

By Nov. 1 the outstanding obligations on orders placed for engineer material, equipment, and supplies, aggregated $130,000,000, and disbursements in payments for material delivered had reached the sum of $15,000,000 per month.

Another important task of the engineers has been to provide efficient methods for the receipt, storage, and shipment abroad, with proper accounting system, for this mass of supplies as well as for the vast equipment for field operations and construction work.

The engineers of the railway section have undertaken to transport and install and put into operation overseas a complete railroad equipment. The railway problem in the theater of operations in France, involves not only the organization, equipment, and military training of railroad troops for the construction, maintenance, and operation of standard and narrow gage roads necessary for the supply of our armies, but also the purchase, inspection, and shipment of immense quantities of railroad equipment—rails, ties, locomotives, cars, shop tools, etc.—necessary for the development of adequate port facilities, construction of new lines and their successful operation. The estimate of the situation in France was confirmed by the French commission, headed by Marshal Joffre, and the means of meeting it have been carried on with intensity.

Trained officials in various departments of American railroads were called upon for the officers, and experienced railroad employes for the enlisted men, of the nine railroad regiments, each of 33 officers and approximately 1,100 men.

The cost of materials ordered to date is approximately $70,000,000, including some hundreds of locomotives, more than 100,000 tons of steel rails, more than 3,000 complete turnouts, 500,000 ties, 12,000 freight cars, 600 fill and ballast cars, 600 miles of telephone wire and apparatus, as well as vast quantities of construction and repair equipment.

The engineers have also undertaken the work of organizing and equipping special troops for special services, such as lumber supply, road construction, sanitary construction, camouflage service, gas and flame service, mining work, mapping, etc.

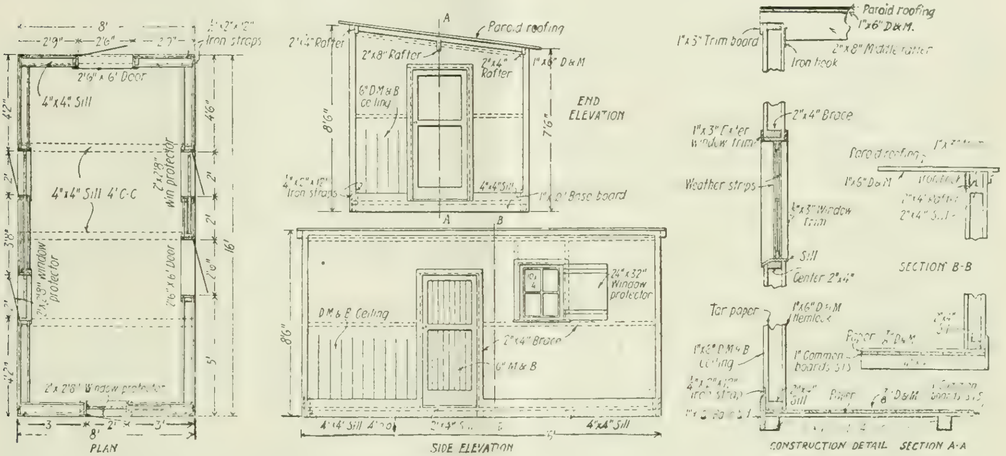
Preferred attention has been given to the organization and equipment of the first forestry regiment, to be sent to France to produce lumber and timber from French forests. Three additional regiments are to be organized. The co-operation of the Forestry Service of the Department of Agriculture has been extended in the selection of personnel and equipment.

In addition to all of these duties, the Engineer Corps has maintained its regular service in the preservation and improvement of navigable waters in the United States and construction of coast defenses. New batteries are being pushed to completion with energy.

On 77 of the principal railroads of the United States, a saving of 114,109 cars was effected in one month this year solely by increasing the average loading of "less than carload" freight. The reports on which these figures are based—the latest have been compiled—cover the months of July this year and July, 1916. They show that the average loading for this class of freight during July this year was 13,927 lbs., as compared with an average of 11,619 lb. during the same month last year.

Portable Wooden Building for Small Construction Crew

A portable building that can be taken apart readily and shipped to another location if desired, thus making it applicable to either temporary or semi-permanent locations, is employed by the Chicago & Northwestern Ry. for housing maintenance of way construction crews. The arrangement was described in a paper presented at the recent convention of the American Railway Bridge and Building Association, from which this note and the illustration are taken.

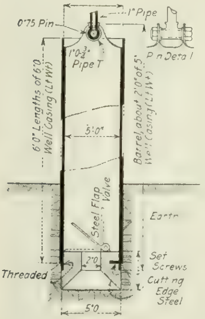


Plan, Side Elevation and Construction Details of Portable Building for Housing Maintenance of Way Gangs.

The structure is 8 ft. by 16 ft. over all with a shed roof 7½ ft. high on one side and 8½ ft. on the other. The sides, ends, floor and roof are separate pieces for convenience in handling, transporting, erecting or taking down. It is stated that the building can be taken down and loaded on cars at a cost not exceeding $5, and that it can be unloaded and erected at a new location for a like amount.

Soil Sampler

The accompanying sketch shows an arrangement devised for obtaining bore samples. The device consists of an outer section, composed of 6-in. light weight well casing, which is forced down by a weighted platform. The inner section is made of 5-in. light weight well casing and carries the cutter. The two sizes of casing rest snugly but not tightly so that the barrel moves freely within the outer case. The arrangement was designed by Mr. R. R. Ryan, C.E., and was first used in 1909 in bringing up samples of the soil at the site of Florence Bridge, Florence, Ariz.



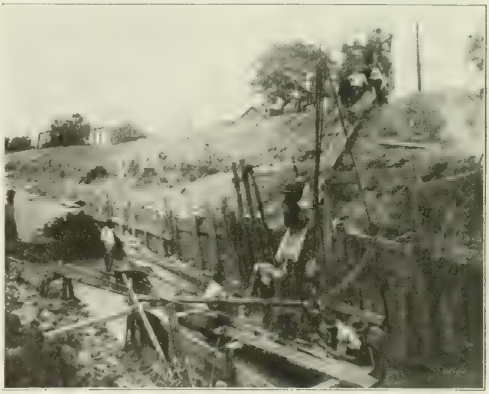
Vertical Half Section of Soil Samples.

Concreting Sewer from Top of Spoil Bank

In the rebuilding of an 11-ft. brick sewer for the city of Cincinnati, O., the contractor expedited the work by placing the mixer on the spoil bank and spouting the concrete directly into the sewer forms.

The contract covers 955 ft. of work, 270 ft. of which is in tunnel. The specifications call for the top to be taken off the old brick sewer to the spring line and the construction of a box top of concrete on the old bed, so as to make a 17 ft. sewer out of it.

The bottom of the old sewer had to be raised several feet. This necessitated the construction of coffer dams and flumes, one of which is shown in the lower center of the illustration. After taking the sediment out of the old sewer the new concrete bottom was placed directly on the old brick floor.



Discharge Chute of Mixer Was Coupled to Spouting System.

A steam shovel was used in excavating the soil above the old sewer and the dirt taken out was all piled up on the north side to give an elevation high enough for spouting the concrete down directly into the forms by the gravity system. The contractor, Mr.

J. J. Foley, is using a Cincinnatus paving mixer of the self-tractor type for the concrete work. As the mixer is easily moved along to keep abreast with the job, it eliminates the expense of constructing runways for wheeling the concrete to the forms. The illustration shows how the discharge chute of the paver was coupled up to the spouting system.

Regulations of State of Washington Regarding Construction Camps

Contractors and all other persons who may establish an industrial camp or camps for the purpose of logging or any like industry or for the purpose of constructing any road, railroad or irrigation canal, or other work requiring the maintenance of camps for men engaged in such work, or any other temporary or permanent industrial camps of whatsoever nature, shall report to the State Commissioner of Health so as to maintain good sanitary conditions, and shall at all times keep such camp or camps in a sanitary condition satisfactory to the State Commissioner of Health.

The health officer of each county shall report to the State Commissioner of Health on the location and sanitary conditions of all industrial or construction camps within his jurisdiction in the month of June each year, and at such other times as the Commissioner of Health may require.

All contractors and other persons responsible for the control and management and construction of industrial camps must use all responsible precautions to protect the men in their employ from disease and to that end they shall comply with the following regulations adopted by the State Board of Health.

The following are the instructions and recommendations relative to the proper sanitation of camps. The natural topography of the land where camps must of necessity be located renders it impossible to specify in detail complete plans for temporary camps, but the management of camps will be held strictly responsible for failure or refusal to comply with the general intent and spirit of these regulations.

Camps must be established upon dry, well-drained ground.

All natural sink holes or collections or pools of water must be drained and filled when the camp is first established.

The stable and kitchen must be separated by a distance as great as consistent with the natural topography of the land upon which the camp is located.

The toilets must be located convenient to the bunk houses, and as far removed from the kitchen and eating house as may be practicable.

The use of toilets provided for the men must be made obligatory, and instant discharge of any employe polluting the soil in the camp must be rigidly enforced.

In camps of 100 or over there must be one employe whose principal duty shall be to act as scavenger and garbage collector.

All manure from the barns must be collected and burned at least once in each week. Instead of burning, the manure may be used as fertilizer on fields not less than ½ mile from camp.

All toilets in the camp must be fly-proof. (The State Board of Health will furnish drawings of inexpensive fly-proof toilets upon request.)

The kitchen and eating house must be effectively screened against flies.

Garbage must be collected in tight cans and burned or buried daily. Garbage may be fed to pigs provided the pen is located not less than 100 ft. from the cook or eating house and kept in a sanitary condition.

Tin cans and other non-inflammable refuse must be collected daily and burned over every 10 days or buried in a pit.

Food supplies must be carefully screened and thorough and systematic scrubbing of kitchen, eating houses and bunk houses must be observed.

The supply of water for the camp must come from an absolutely uncontaminated source.

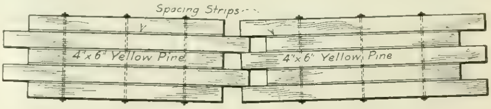
Care must be taken not to pollute the water supply of another camp or the water supply of any of the people of the State of Washington.

All sick from whatever cause should be isolated from the remainder of the crew immediately.

All persons engaged in the care of the premises and handling of the food, particularly cooks and helpers, should be carefully examined and particular attention paid to the point as to whether or not they have suffered from typhoid fever within recent years.

Timber Track Sections for Light Steam Shovels

Timber track sections, constructed as shown in the sketch, have been used with success as runways for light steam shovels. The sections are made of 4x6-in. timbers with thin spacing strips between and are bolted together by three ½-in. bolts. The sections shown are 4½ ft. long, but this length would vary with the machine. The runways are particularly serviceable in making turns, as there is enough play in the interlocking joints to permit of the taking up of a section and moving it over one notch, thus allowing the rear wheel to run squarely on it.



Interlocking Runway for Steam Shovel Work.

Personals

Professor Ray C. Yeoman, dean of the engineering department of Valparaiso University, has been appointed assistant professor of highway engineers at Purdue University, and will take up his duties on Dec. 1. He succeeds G. E. Martin, now a captain in the U. S. Army.

J. E. Lewis has been appointed engineer in the office of the Supervisor of Public Utilities of Dallas, Tex., and will devote his time in supervising the construction of electric railway lines and other improvements planned by the Dallas Railway Co. and the Dallas Power & Light Co.

Allen F. Brewer, junior member A. S. M. E., formerly a mechanical engineering inspector with the Public Utility Commission of New Jersey, attached to the valuation department, has entered the service of the American International Shipbuilding Corporation at Philadelphia. Mr. Brewer has contributed recently to Engineering and Contracting articles bearing on water utility vauation.

Harold D. Hynds, who has been secretary of the American Concrete Institute for the past two years, has recently enlisted in the engineering arm of the service of the United States. In consequence of this step he tendered his resignation as secretary, which has been accepted by the Board of Direction. Henry B. Alvord, who has been Administrative Assistant for the past nine months, has been appointed as Secretary. Mr. Alvord is a graduate of the Massachusetts Institute of Technology, class of 1907, in the course of civil engineering. After being connected with the Institute of Technology for three years as Assistant in Civil Engineering, he was called to Bowdoin College as instructor in civil engineering and geology. Later he was made Assistant Professor in Mathematics and Civil Engineering. For the last three years he has been connected with the Aberthaw Construction Company of Boston. He will continue his present duties in connection with those of the Institute.

Building and Structural
Monthly Issue

ENGINEERING AND CONTRACTING

Halbert P. Gillette, *President and Editor.* Lewis S. Louer, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

Volume XLVIII. CHICAGO, ILL., NOVEMBER 28, 1917. Number 22.

ATTENTION!

Turn back three pages to advertising page 12. The publishers of Engineering and Contracting have there printed a message that should interest you.

Some Important Conclusions from Recent Tests on 200 Steel Columns

Considering the enormous quantity of steel annually used as columns in bridges and buildings, it is remarkable that tests of column strength have been so few in number and on so small a scale. Experimental investigation of the strength of full size columns has been sorely needed, and at last a series of tests on 200 built-up columns has been completed in the Washington Laboratory of the Bureau of Standards under the direction of George R. Olshausen.

These tests disclose the remarkable fact that although the chemical composition and the tensile strength of the steel in two similar columns may be the same, one of the columns made from one lot of steel may show a third less strength than another column from a different lot. This indicates that the compressive yield-point of steel may vary considerably, even where there is no variation in tensile strength. Compression tests on channels and I-beams now in progress confirm this conclusion. The compressive yield-point is certainly affected by the process of rolling the steel, for columns made of steel ¼ in. thick showed about 10 per cent more strength per square inch than those made of steel ½ in. thick. In general, the columns made of thick metal showed less unit strength than those of thin metal. Apparently the degree of compression by rolling affects the compressive yield-point to an extent hitherto not appreciated.

Another surprising result of the tests is the demonstration of the fact that tie-plated columns are much weaker than latticed columns. On the average the tie-plated columns were only 60 per cent as strong as the latticed columns. The tie-plates were about 8 ins. in height and 10 ins. wide, and spaced about 4½ ft. center to center. Had they been spaced less far apart, the resulting strength would probably have been greater. Nevertheless, these tests seem to indicate that latticed columns are to be preferred to tie-plated columns.

The tests on solid section, built-up columns show that the shape of the section has no influence on the column strength.

In the matter of the effect of the "slenderness ratio" or "length ratio" (i. e., length divided by radius of gyration), the tests serve to establish one important fact, which is in concordance with previous knowledge. A pin-ended column whose slenderness ratio is 25 or less, or a square-ended column whose slenderness ratio is 50 or less, has an ultimate unit strength only slightly less than the compressive yield point of the steel in short blocks. The steel used in these tests had a yield point of about 38,000 lbs. per sq. in. and a tensile strength of about 60,000 lbs. per sq. in. in small-sized pieces.

For slenderness ratios up to 72 for pin-ended columns, there was found to be a decrease in unit strength fairly in accordance with the theoretical formulas in common use; but the influence of the yield point is shown in all tests up to a slenderness ratio of 72 for pin-ended columns. Hence the Euler formula fails of complete generality.

All tests were made on square ended columns. hence the slenderness ratio of the square-ended columns must be divided by 2 to convert to the equivalent slenderness ratio of pin-connected columns. It is to be hoped that later tests will be made to establish experimentally the correctness of the theory upon which the use of this factor of 2 is based. It is also to be hoped that pin-ended columns of greater slenderness ratio than 72 will be tested.

The strain-stress curves of the column tests are straight lines almost up to a unit stress equal to the compressive yield point of the metal in short blocks. Then there is sudden flattening of the strain-stress curve. Hence the factor of safety is practically equal to the compressive yield point divided by the working stress, for equivalent pin-ended columns having a slenderness ratio of 25 or less. The average ultimate strength of such short columns ($l \div r = 25$) was about 33,000 lbs. per sq. in., but there were variations, both ways, of 20 per cent from this average. For equivalent pin-ended columns having a slenderness ratio of 60 the average ultimate strength was 26,000 lbs. per sq. in., and here again variations of 20 per cent from the average occurred. As previously stated, columns built of thin metal showed considerably greater unit strength than those of thick metal. So uniformly was this the case that it would seem that ultimately it may become the practice of designers to use higher working stresses for thin sections. These results show very clearly the futility of great requirements in calculating unit stresses in columns. What avails it to know the stress almost exactly when such wide variations in ultimate strength exist?

The "Cost Plus a Fee" Contract for Building Work

About 15 years ago Frank B. Gilbrath started an advertising campaign in the civil engineering periodicals that made the "cost plus a fee" form of contract famous. Mr. Gilbrath advocated what he called the "cost plus a fixed sum contract." His work consisted mainly in erecting industrial buildings and power plants. During the last decade many contracting firms have adopted the "cost plus a fee contract," and it has steadily grown in popularity in the building field.

Mr. J. P. H. Perry, manager of the Turner Construction Co., specialists in reinforced concrete buildings, says that the tendency in reinforced concrete building construction is more and more toward putting the contractor on a professional basis. This is accomplished under a "cost plus" form of contract. Not only are reinforced concrete buildings more susceptible to serious defects from poor workmanship, but the contractor, particularly if he is an engineer or employs engineers, can often point out betterments in design. Under a "cost plus" contract, the contractor has nothing to gain by slighting the work and everything to lose, for he secures contracts solely because of his reputation and not because he is the lowest bidder. Under the "cost plus" contract it is also to his interest, since it enhances his reputation, to point out to the owner or his representative any economies that can be effected by changes in the design; and there is no gainsaying that even the most skilled structural engineer or architect can frequently improve a design by adopting an experienced contractor's suggestions.

On another page we print an article by Fred A. Jones on "Lump Sum Versus Cost Plus Contracts," which contains a splendid summary of arguments, pro and con, relative to the "cost plus" form of contract.

Another article in this issue gives in detail several "cost plus" forms of contracts, together with a discussion of the advantages of the "cost plus" contract as set forth by H. L. Rogers, Manager of Division of Construction and Engineering for Stone & Webster.

The "cost plus a fee" form of contract has received an unprecedented amount of free publicity in connection with the government contracts for cantonments and ships. Therefore it will be easier than hitherto to persuade private owners and public officials to adopt this form of contract for structural work. Contractors, however, will find it necessary to continue giving publicity to the "cost plus" contract; and already several engineering contracting firms have begun to advertise quite extensively to secure contracts on a "cost plus" basis.

Rapid Methods of Estimating Costs of Buildings

The square foot of floor area and the cubic foot of total volume are the two units in which the costs of buildings are commonly expressed by those who apply rough and ready methods of estimating. But obviously such unit costs are subject to wide variations, even in buildings of the same type. Much more satisfactory than the square foot of floor area for approximate cost estimating purposes is the square foot of wall, floor and roof, with the basement and foundation estimated separately. Then each type and class of wall, floor and roof can be estimated by itself.

To prepare unit costs for estimating a given type of wall, for example, the estimator first prepares a bill of materials for, say, 100 sq. ft. of wall, and applies unit prices, including labor, to all the materials, totals the items and divides by 100. The same is done for windows and doors, so that, knowing the total area of "openings" the cost is readily estimated.

Preferably the cost of columns is estimated by the linear foot, but, if desired, the cost of columns may be included as a part of the cost of the floors. Basements may be estimated by the cubic foot, to which may be added the cost of any special foundation work, such as piling, and the cost of the floor. The "equipment"—plumbing, heating, lighting, sprinkler system, elevators, etc.—should be estimated separately; but this, at least in part, may often be estimated by the square foot of floor area. Thus the cost of a factory heating system may be taken at 25 ct. per square foot, and the cost of a fire sprinkler system at 20 ct. per square foot of floor.

Between the very crude method of expressing the entire cost in terms of the square foot of floor area and the very refined method of detailing all quantities in a building, there stands the method above suggested, in which composite units of different types and classes are used.

The Contractors and Builders Show in Chicago

The "Cement Show" has been an annual feature in the structural field for so many years that most of our readers are familiar with its character. Next year, Feb. 6 to 13, the Cement Show will be enlarged to cover a much wider field. In fact the plan is to cover a large part of the civil engineering and contracting field with the exhibits. Negotiations are under way to bring to Chicago the meetings of such societies as the American Board Builders, the National Builders' Supply Association, the National Paving Brick Manufacturers, the American Concrete Institute, and others. An excellent opportunity now presents itself to hold one great annual exhibition that will include all the materials and equipment used in the civil engineering and contracting field. We trust and believe that this will be accomplished.

Educate the Public to Curtail Luxuries in Order that Construction May Not Be Curtailed

Were it not for the annual savings of the so-called capitalistic class there would be a scant amount of money available at any time for the construction of buildings, mills, railways and other plants. The average man spends all that he earns as fast as he earns it—often a little faster—and it goes mostly for what he is accustomed to call "necessities," but what in reality are luxuries. We do not decry expenditures for luxuries when held within such bounds that enough capital remains to provide for the rapid economic progress of society. But we do say that, taken by and large, the average man sadly needs to be taught that it is his social duty to save a fair part of his annual income—say, 15 per cent—for investment. The "liberty bond" advertisements have led many people to save money for financing the war, but this is not enough. There is need of both advertisements and editorial exhortation to increase the deposits in savings banks with a view to ultimate investment in revenue producing properties—public utilities, factories, mines, etc.

America as a Shipbuilding Nation and the Opportunity for Structural Engineers and Contractors

The government has already ordered 1240 ships totaling nearly 8,000,000 tons, and will soon place orders for 400 more, bringing the grand total up to 11,000,000 tons. Never in the world's history has any nation embarked on such a stupendous program of shipbuilding. Aside from the engines that drive it, a ship is essentially a framed structure, and most of the problems involved in its design are akin to those encountered in designing a "skyscraper." Also the problems of the shipbuilder are very similar to those of the contractor for a large building. The number of engineering contracting firms that have already taken government contracts for ships is evidence of the fact that shipbuilding is merely a branch of structural engineering. Structural engineers and contractors will find in ship designing and building a most inviting field during the war, and one that is not likely to decrease in attractiveness after the war ends; for, once started in this wholesale manner, America is destined to build ships, even as it has for a generation been erecting "skyscrapers" and bridges—"by the mile."

Recruits Wanted for the 28th Engineers, the Quarry Regiment

Another volunteer regiment of engineers is being recruited for service in France, to be known as the Quarry Regiment. It will consist of 6 companies of 250 men each, and its special work will be the quarrying and crushing of rock for roadwork, ballast, concrete, etc. Each company will be equipped with a plant having a daily capacity of 1,000 tons of crushed stone. The equipment will include drills, steam shovels, locomotives, cars, locomotive cranes, motor trucks, and other construction equipment. Men are needed to supervise and operate this equipment. Engineers and contractors are urged to call the attention of skilled workmen to their opportunity to serve the government. Read the enlistment advertisement in this issue, where salaries are given. Communicate with Maj. O. B. Perry, 28th Engineers, War Dept., Washington, D. C.

Some Data on the World's Highest Building and Their Significance

From the sidewalk to the apex of its tower, the Woolworth Building is 785 ft. high, overtopping its next New York rival, the Metropolitan Building, by 85 ft. But its cellar is 55 ft. deep, making the real height of this structure total 840 ft. The underground work alone cost $1,000,000. In the superstructure there are 23,000 tons of steel and 17,000,000 brick, not to mention 7,500 tons of terra cotta and 28,000 tons of hollow tile. More than 70,000 barrels of portland cement were used in this one building. The entire building weighs 125,000 tons, or nearly 5.5 times the weight of the structural steel. The water supply and plumbing lines total 40 miles of wrought iron pipe—enough to serve a small city. We name some of the large quantities in this huge structure to indicate more clearly to our younger readers that the design of large office buildings is primarily structural engineering. Important as the architect's work on such buildings may be, the engineer's work is even more important. Economics overshadows esthetics. Hence more structural engineers are annually forming copartnerships with architects, instead of remaining as employes of architects.

The Importance of Hooks at the Ends of Reinforcing Bars in Concrete Beams

In discussing the report of the Am. Soc. C. E. committee on concrete, L. J. Mensch makes the criticism that the report fails to lay enough emphasis on the importance of hooks at the ends of reinforcing bars. He cites the tests of the German committee on 100 beams for the purpose of discovering the effect of hooks on beam strength, and he says:

> In this long series not one beam can be cited where the omission of hooks did not show a marked reduction of the ultimate load over bars with large hooks. Where hooks were omitted in one-quarter of the bars the drop was about 10 per cent, where one-half of the bars were without hooks the drop was about 20 per cent, and where all the bars were without hooks the drop was 50 per cent and more. This importance of hooks in simple beams is greatly underestimated in the United States, and wrong conclusions are often drawn from tests, because the great influence of hooks is overlooked.
>
> Professor Moersch made tests on beams reinforced with deformed bars without hooks, and found the drop the same as with plain bars without hooks. The great importance of hooks is also shown in the tests made by Professor Talbot on wall and column footings. In the face of these facts, the paragraph, "As an additional safeguard end anchorage may properly be used in special cases" and "anchorage of longitudinal bars at the ends of beams is advantageous," will not impress on the reader the importance of the subject.

Mr. Mensch criticises the committee for nearly neglecting the work of the French committee (1902 to 1905) and of German committee (1908 to 1915) by whom many mooted questions were solved.

How a Structural Engineer Became a Successful Competitor of Architects

In his paper on the Hell Gate Arch Bridge, referred to elsewhere in this issue, Mr. Ammann says:

> Engineering structures are still regarded by many engineers as mere works of utility, which deserve no consideration in architectural or artistic treatment. So long as this opinion prevails the engineering profession will not lift itself to a higher plane, and it is even running the risk of being relegated to second place—or after the architect—in the creation of such monumental structures as properly belong in its domain.

True, and does it not also follow that, even in structures that are not monumental, the structural engineer has often been relegated to second place because of his failure to appreciate that esthetic treatment can not be profitably slighted? Not long ago a structural engineer told the editor that it took him some time to learn why he could not sell his services in competition with architects. Finally he discovered that the average client is so greatly impressed by the wash drawings made by architects that the plain black and white drawings made by an engineer receive scant consideration. Thereafter he began to color his drawings, and coincidentally to secure commissions for the design of buildings. Moral: If you would win out as a structural economist, first get the job as an artist.

Protecting Old Stone Masonry With Cement-Gun Mortar

About the first recorded instance of the use of Portland cement in American railway structures was the covering of old stone masonry culverts on the Erie Railroad with concrete. The frequent repointing of stone is alone sufficient justification for covering it with a cement mortar slab, in many cases; but when the stone is of a character that slowly disintegrates by "weathering," there is only one ultimate solution of the problem, namely surfacing with cement mortar or concrete. Recently a rubble arch bridge near Lancaster, Pa., was surfaced with cement mortar applied with a cement gun. The bridge was built more than a century ago, and had disintegrated badly. Loose mortar was picked out of the joints and wire mesh was fastened to the face of the masonry with boat spikes driven into the joints. Then a 1:3 mortar was shot on, covering the surface to a thickness of 2 in. The Dewey Cement-Gun Construction Co., of Allentown, Pa., covered 11,000 sq. ft. in 14 days of work with the "gun," or 800 sq. ft. per day.

The New Carnegie "Shape Book"

The sixth edition of the "Shape Book" of the Carnegie Steel Co. (Carnegie Bldg., Pittsburgh, Pa.), is just off the press, and can be secured from the main office or from any of the 14 district offices, for $1 per copy. The book contains 352 pages and is handsomely bound in green leather. It contains 265 pages devoted to profiles of sections, giving detail dimensions and weights. The noteworthy increase in the number of rolled sections, as compared with the last edition, is attributable, in large measure, to the great development in the use of steel in frames for windows, doors, and skylights in factory buildings. Also the remarkable expansion in shipbuilding has resulted in the rolling of many new sections. Every structural engineer will want a copy of the "Shape Book."

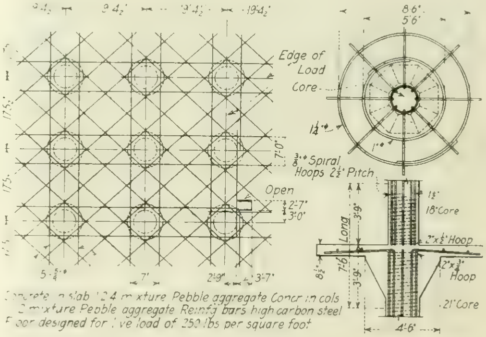
Test of Reinforced Concrete Floor in the Western Newspaper Union Building, Chicago

By JOS. E. LOVE.

Engineering Department, Chicago Union Station Co.

Probably the first test to destruction ever made of a reinforced concrete structure which had not been built specially for test purposes and which had been in commercial use for several years, was recently completed in Chicago. This test was made on the sixth floor of the old Western Newspaper Union Building now being wrecked to make way for the head house of the new Chicago Union Station. The structural engineers of the station company, believing some portions of the old building presented unusual opportunities for an investigation of the strength of reinforced concrete, arranged for a test with the W. J. Newman Wrecking Co., the Portland Cement Association, the Universal Portland Cement Co., the T. L. Condron Co., the Illinois Steel Co. and the University of Illinois.

The building, which is described in an article on its wrecking in this issue of "Engineering and Contracting," was designed for large live loads, the design of the tested floor having been for 250 lb. per square foot.


9'4½'
9'4½'
9'4½'
19'4½'
8'6'
5'6'
17'5½'
17'5'
Edge of Load
Core
1¼"
1"
7'0"
⅜" Spiral Hoops 2½" Pitch
Open
2'-7"
3'-0"
Long
3'-9"
1½"
18" Core
2"x½" Hoop
7'-6"
8½"
3'-9"
2"x¾" Hoop
21" Core
4'-6"
5-⅝"
7'
2'-9"
3'-7"
Concrete in slab 1:2:4 mixture Pebble aggregate Concr in cols
mixture Pebble aggregate Reinfg bars high carbon steel
Floor designed for live load of 250 lbs per square foot

Plan of Tested Portion of Floor and Typical Column Details.

Because the funds available were limited, but one test could be made, and for this purpose four interior panels of the sixth floor were selected. These panels were 17 ft. 5½ in. by 19 ft. 4½ in. between column centers. The design called for the flat slab type of construction with an 8½ in. slab, reinforced four ways, with the direct and diagonal bands 7 ft. wide each carrying 15 ⅝-in. round rods. The width of the octagonal column caps was 4 ft. 6 in. at the ceiling and no drop panel was used. The short diameter was 24 in. for the columns of the fifth floor and 21 in. for those of the sixth floor, while the column cores were 21 in. and 18 in., respectively. At all columns the outer ring of the spider was a 1¼ in. round, 8 ft. 6 in. in diameter, the inner ring a 1 in. round, 4 ft. 6 in. in diameter. The column longitudinal reinforcement consisted of eight 1½ in. rounds, bent out radially at the floors and running beneath the spider rings. The hooping of ⅜ in. rounds had a pitch of 2½ in. Tests of reinforcing rod specimens taken from various parts of the building proved the material to be a high carbon steel instead of the mild steel ordinarily used for reinforcement. These specimens gave a yield point of 65,000 lb. per square inch and an ultimate strength of about 100,000 lb. per square inch. A concrete with pebble aggregate of 1-2-4 mixture was used in the slabs, and of 1-1-2 mixture in the columns.

In preparation for the test 200 gage lines on the steel and the concrete and deflection points were arranged with a view of ascertaining the strains in the materials in critical places and the action of the slab under load. After taking preliminary measurements the panels were loaded with pig iron and after each increment of load, amounting to 200 lb. per square foot, had been placed, observations were made at all gage lines and deflection points. Care was taken in placing the pig iron to eliminate the possibility of any arching action in the material itself. When the load of pig iron reached about 340 lb. per square foot, the maximum deflection at the center of the panels was 0.33 in., the maximum stresses in the steel, 23,000 lb. per square inch, and in the concrete about 1,500 lb. per square inch. Loading was continued until 1,232,000 lb. of pig iron was on the four slabs, which is the equivalent of 910 lb. per square foot. Adding to this the weight of the slab gave 1,015 lb. per square foot for the total load. The superimposed load was 3.64 times the designing live-load and the total load was 2.9 the designing total load. The maximum deflection produced was 1.1 in. Preliminary computations gave the following as the indicated average stresses in the steel:

	Lb. per sq. in.
At the center column, diagonal rods	52,000
At the center column, direct rods	31,000
At center of panels, diagonal rods	18,400
At center of panels, direct rods	23,800

Final Load of 910 Lb. of Pig Iron Per Square Foot in Place.

Stresses in the steel calculated for the test load compare favorably with the above measured stresses for that part of the slab located at and near the column cap. However, the presence of an arching action in the central portion of the panels is indicated by the fact that the calculated stresses in the steel there are higher than those measured. The compressive strains in the concrete at the bottom of the slabs at the center column were in the neighborhood of .0012 to .0015. Inasmuch as laboratory tests have not yet been made on the concrete specimens taken from the building, the stress corresponding to this strain is not known, but this deformation is that of concrete at about its ultimate strength. Spalling of the concrete around the column capitals substantiates the belief that the concrete had reached this stress. In view of the results of previous tests on reinforced concrete columns, it can be stated that none of the columns was greatly stressed, the center column, which naturally carried most of the load, being stressed only to about one-fourth of its ultimate strength. A few days after this point of incipient failure of the slabs the load was removed and measurements again taken, those in charge of the test having decided it would be of greater value to watch the slabs recover after the removal of the pig iron rather than to test them to complete destruction. The permanent deflection was approximately 0.35 in. The location of the largest unit radial stress in the concrete was clearly disclosed by cracks in the slab following the perimeter of the capitals underneath more or less closely. Cracks also developed in the bottom of the slabs at the center of the panels and in the top of the slabs along the lines indicating the edges of the panels. All of these cracks followed those lines where they were expected to appear.

The value of the test consists not merely in showing the strength of these slabs, but also in showing how the stresses are distributed throughout the floor and what proportion of the load is taken by the various systems of reinforcement. However, the fact that only four panels were loaded limits the value of the data in its bearing upon moment coefficients for use in design. In the opinion of some engineers the test indicates that too great a factor of safety is used in reinforced concrete design, while others are convinced it justifies present standards and advance several reasonable arguments to support their views. For instance, when the slabs were broken up after the test, the concrete in three of the panels was found to be quite hard, while that in the fourth was broken with comparative ease, showing that with the present practices of mixing and placing, concrete cannot be made a homogeneous material such as steel and is therefore not thoroughly reliable in regard to its properties. Then too, the reinforcing bars in the tested floor had a strength greatly in excess of those ordinarily used. Another point overlooked by many discussing the investigation was the fact that a number of the bars were overlapped at the columns to such an extent that more steel than that indicated by the design was useful to resist the stresses at that point, where they are known to be greater than at other parts of the floor system.

An investigation of the design of the floor, based upon a ruling on flat slabs made in 1914 by the Chicago Building Commissioner, showed that parts of the tested slabs contained about twice the amount of reinforcing than would have been required by the ruling and that, in general, the slabs were too heavily reinforced for the thickness of 8½ in. This investigation of the design did not take into consideration the fact that the rods, after overlapping at the columns to secure continuity of their action, extended beyond about one-third of the span between columns in some cases. In other words, had the design of tested slabs been based upon this 1914 ruling and had the overlapping of the rods and the quality of the steel been in conformity with usual reinforced concrete standards, it is quite evident that the floor would not have been able to sustain so great a load as was placed upon it in this test. How much of a load the slab would have carried is a matter of speculation, yet the fact remains that though the stresses in the steel had not as yet reached the yield point, the stresses in parts of the concrete had practically reached that point, as was evidenced by the condition of the concrete in the slabs at the column capitals.

The test covered a period of over three weeks and cost in the neighborhood of $3,000. It was conducted under the direction of Prof. A. N. Talbot of the University of Illinois, by H. F. Gonnerman, who was in charge, and by representatives of the co-operating companies.

Construction of Industrial Villages for Workmen

One of the important problems at the present time in many industries is the proper housing of the large number of new workmen necessitated by the great increase in manufacturing activities. In ordinary times an increase in number of factory employes is usually taken care of in cities and towns by real estate people and those who build for investment. Under present conditions, however, when a factory force may be doubled in a few days this method is wholly inadequate.

In England the problem of providing facilities for workmen engaged in war-time manufacturing was met by the formation of new communities and the building of whole towns by the Government. In some cases these towns are almost 10 miles square, and are provided not only with ordinary houses and living accommodations, but with public parks, playgrounds, theaters and everything needed in a modern town. The United States also in some cases has taken steps to care for the men engaged in ship construction. For some of the recent destroyer contracts, the Government itself will finance the building of barracks or temporary hotels, so that several hundred men can be housed in or near the shipyards where the work is to be done. Last week announcement was made that the Government would loan enough money to build 1,500 houses for workmen of the Sparrows Point branch of the Bethlehem Steel Co.

Many manufacturers are now carrying out housing propositions of their own. Two of the more recent projects of this kind are described below.

Industrial Village Completed in 3 Months.

The demand for tire fabrics has increased so much of late that the Goodyear Cotton Mills, Inc., was this year forced to increase its facilities at Killingly, Conn. Winter weather and frozen ground were not allowed to stand in the way for the need was urgent.

Accordingly, the Aberthaw Construction Co., of Boston, was entrusted with the contract to erect 88 workmen's houses, a large hotel for single men, and a 7-story storage building.

Work was started on Jan. 2d, it first being necessary to construct a labor camp to house the contractors' men. Furthermore, on account of the fact that the site was 2 miles from the nearest railroad station considerable work had to be done repairing the country roads so they would be in shape to stand the heavy traffic.

The 88 cottages contained, respectively, 4, 5 and 6 rooms, with solid concrete cellars and foundations. For reasons of economy most of these were built either semi-detached or in the case of the 4-room cottages, in blocks of four. Twelve single houses of 6 rooms each were provided for better paid employes who were able to pay the rent for these dwellings. Above the first floor the houses were built of wood frame, lathed and plastered inside and covered with shingles on the outside. The roof was covered with fireproof shingles of asphaltic felt.

The notable feature of this work was the speed with which it was carried out, only three months being required to erect the 88 houses.

The hotel was designed to accommodate 50 single men. Concrete foundations were built, framing was completed in three weeks, and the large house was plastered and finished in eight weeks of cold winter and spring weather.

The storehouse itself, designed by Charles T. Main of Boston, was of reinforced concrete, seven stories high and of dimensions 102 by 122 ft., having a loading platform running the whole length of the building 8 ft. wide.

Industrial Village, 2 Miles from a Railroad, Completed in Three Months.

Special gangs were organized to take care of each operation of the work so that instead of one gang of carpenters putting up the framing and completely finishing a house, there were separate gangs that framed house after house. Other gangs followed, putting on outside finish, while other gangs laid floors. There was a gang for stairs and porches, another for inside finish and so on. Each gang knew how long it would be before a subsequent gang would be along to take the next step, and they accordingly worked at top speed.

The whole of the work on the vilage, including water supply and a sewer nearly a mile long was completed in 3 months.

The Housing Proposition of the Youngstown Sheet & Tube Co.

One of the most elaborate housing propositions in progress in this country is that of The Youngstown Sheet & Tube Co., Youngstown, O. It consists of three sections, in fact, each designed to meet a separate and distinct set of conditions, and each involving special problems. In all 750 individual dwellings are included, 146 of these being located at East Youngstown, on the north side of the company's steel plant; 450 at Campbell Park, on the south side of the works, and 154 at Nemicolon, a new coal town being erected by the corporation at its large coal operations in Greene County, Pennsylvania, where 5,000 acres of by-product coking coal are being developed.

From a building standpoint the most interesting section is probably that at East Youngstown, where homes are being erected to house that portion of the company's foreign-born workmen who desire better living quarters than are usually to be found among the tenements surrounding a large steel works. These houses are being erected of concrete units. The work is being done by the Unit Construction Co., of St. Louis, Mo.

These houses are being erected of separate units, each being cast in a mold with a special grade of concrete. The units are of varying size and many different shapes, being designed so that when they are lifted into place with a crane, they will fit together and be held in position by interlocking. Some of the units are sides of a house, with all the door and window openings provided. Others are complete floors, having openings for flues, stairways, piping, etc., and the lower side artistically panelled for a ceiling. Others are for the porches at front and back, and still others for the stairways. Practically all are reinforced with light steel. They are cast in a well arranged yard and when properly seasoned, are assembled in place by a truck specially built for that purpose. Some of the units weigh as much as 1½ tons, although the greater number are much lighter.

The houses will be roofed with Imperial Spanish tile on wooden framing, and all of the interior trim, including the floors (except in the bathrooms and basements) will be of wood nailed to strips dovetailed in the cement at time of casting. The interior walls will be plastered, furring strips being inserted in the slabs for this purpose. All will be painted with a special mixture.

The units to be used as side walls, partitions, and in all places where they will be exposed to dampness in the atmosphere, are cast hollow by an ingenious method. The cast is first made for one side of the slab, this mold having a rim several inches wide and 2 in. deep. The hollow is then filled with granulated slag and the other half cast on this bed. The concrete is dampened at the edges, which causes it to form a solid block except for the portion filled with slag. After it has set, the slag is loosened with rods and poured out through openings at all four sides. A hollow, damp-proof slab is thus secured.

Blast furnace slag has been used to a large extent in the mixing of this concrete, and has been found to serve better than sand and gravel, one of its results being a handsome dead white surface which gives the buildings a very distinctive appearance.

The houses are of various sizes, some having 4 rooms and bath; others 6 rooms and bath, and a few 7 rooms and bath. They are usually built in terraces, although there are a few single houses, these being made necessary by the elaborate street plans, which include parks, playgrounds, a swimming pool and other features that are expected to make the community rather unique in its class. Each house is provided with a shower bath in the basement for the men coming from the mills, and each has a good sized garden. They will be equipped with electric light, water, gas and all modern conveniences. With their white walls, red tile roofs and the elaborate landscape arrangment, these houses will present a striking appearance when completed.

Unlike the houses above described, which are to be rented, the corporation has well under way another plan for housing its American workmen. This consists of a tract of 80 acres on the south side of the plant and adjacent to the main south gate. The land lies on a high elevation close to the works, but across the Mahoning River from them. It is being laid out in a most attractive way under the direction of John Nolan, landscape artist, Boston, and when completed the tract will have wide paved streets, curving drives, and many features that will tend to beautify and make it attractive.

On this ground will be erected about 450 homes of many different sizes and designs, as well as of many different materials. They are to be sold to workmen and officials in the operating department, and the purchasers will be permitted as fas as possible to dictate the design and size of the houses. All, however, will be erected wtih regard to the harmony and general beautification of the property, and restrictions certain to maintain this will be enforced. The houses will cost between $3,000 and $7,500, and will, of course, be furnished with the ordinary conveniences.

Provision has been made for parks, schools and community centers, and one large park is already in fairly complete condition. As the land is wooded, an effort will be made to save as many of the fine trees as possible.

In order to expedite the work and avoid delay due to congested conditions in the labor and material markets, the first 100 of these houses were purchased ready cut from a number of concerns dealing in such material. This plan will probably be abandoned as soon as enough homes have been provided to relieve the housing situation. About 100 houses are now under roof and the work of grading and landscaping has made good progress.

These houses will be sold to employes of the company on a basis of actual cost, and purchasers will be given terms of payment much more liberal than can ordinarily be obtained. The purpose is to provide homes for workmen who desire an opportunity to improve their surroundings, rather than to realize any profit from the proposition.

The erection of houses at the mining town of Nemicolon, while a somewhat smaller proposition than either of those referred to above, is interesting as developing an entirely different sort of dwelling. This has not as yet progressed sufficiently to permit of description.

All three of these housing propositions are being conducted by the Buckeye Land Co., a corporation created for the purpose. They will require several years for completion and will cost considerably more than $1,000,000.

Cement Testers and Inspectors Wanted by U. S. Bureau of Standards.—The purchase of enormous quantities of cement by the Government in the present emergency has created an urgent need for experienced cement testers and inspectors in the testing laboratories of the Bureau of Standards. The Civil Service Commission has therefore announced a registration of eligibles for appointment to these positions at salaries of $900 to $1,000. Detailed information regarding these appointments can be obtained from the Civil Service Commission, Washington, D. C.

Diagram for Use in Designing Timber Columns

By W. S. WOLFE,

Instructor in Architectural Engineering, University of Illinois.

The diagram here presented for use in designing timber columns has two features which are of special interest. First, it has been computed for the actual size of standard timbers, and not for their nominal size. The nominal size of a 10x10 is 10 in. x 10 in., but the actual size is about 9½ in. x 9½ in. In locating the inclined line for the 10x10 the dimensions 9½ in. x 9½ in. were used and the line is marked 9½ in. x 9½ in. Second, there is a convenient arrangement for taking care of the variation of the allowable stress on short blocks for different kinds of wood.

Construction of Diagram.—The line, xy, was drawn dividing the diagram into two parts, and transverse lines were drawn perpendicular to the line, xy, at intervals of 5,000 lb. In the "B" half of the diagram the length lines were drawn parallel to, xy, while the inclined lines, each of which represents a certain sized timber section, were drawn by locating two points on each one of them, by means of the formula

$$S = C\left(1 - .0125\frac{L}{D}\right)$$

in which, S, is the allowable average stress for the column in pounds per square inch, C, is the allowable compression for short blocks in pounds per square inch, L, is the unsupported length in inches, and, D, is the least lateral dimension in an unsupported direction. For locating the points for all of these enclined lines, C, was taken as 700 lb. per square inch, because the line, xy, is the 700-lb. C line.

In the "A" half of the diagram, over at a convenient distance from, x, a line was drawn parallel to, xy, and called the 1,400-lb. C line. Along this line 5,000-lb. divisions were made just half as long as those along the, xy, line which is the 700-lb. C line. The corresponding divisions on these two lines are connected and the inclined load lines obtained. The other C lines were then drawn in at their proper places.

Use of Diagram in Solving Problems.—Four different types of problems can be solved by the use of the diagram.

First: The load, length, and allowable, C, are given and the proper timber section is desired. This is perhaps the most important case. Let the load be 75,000 lb., the allowable, C, 1,300 lb. per square inch, and the unsupported length 14 ft. 0 in. The 1,300-lb. C line is located and followed along until the 75,000-lb. load line is intersected, then following along parallel to the lines normal to the C lines the 14-ft. length line is intersected. Now any of the column sections, represented by inclined lines, outside of this intersection are strong enough. The first line outside is marked 7½x11½, which are the actual dimensions of an 8x12 having a nominal cross section of 96 sq. in. The nominal cross section is given in place of the actual because it is the nominal that we pay for. The next inclined line outside of the intersection is marked 9½x

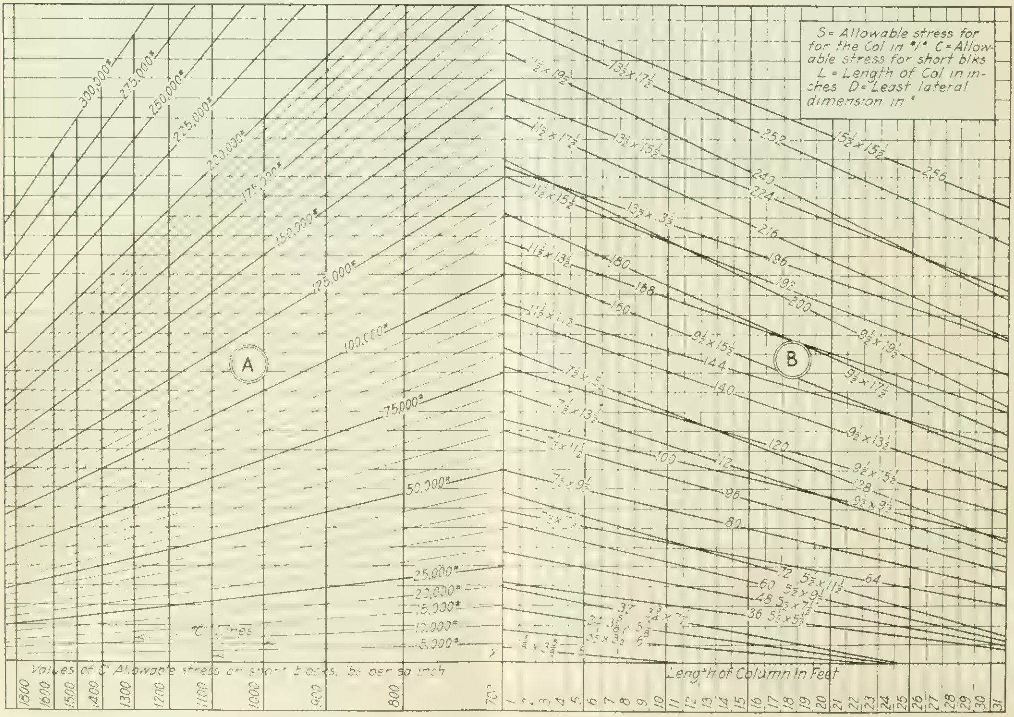


Diagram for Use in Designing Timber Columns. Formula: $S = C\left(1 - .0125\frac{L}{D}\right)$; Chicago Building Law.

$9\frac{1}{2}$, which is the actual size of a 10x10 having a nominal cross section of 100 sq. in., 4 more than the other section had. The choice will probably be between the $7\frac{1}{2}$x$11\frac{1}{2}$ and the $9\frac{1}{2}$x$9\frac{1}{2}$, with the latter being a little more expensive.

Second: The load, column, and length are given and we desire to find the corresponding C. Consider a $9\frac{1}{2}$x$9\frac{1}{2}$ having a length of 12 ft. 0 in. and carrying a load of 100,000 lbs. Follow up along the 12-ft. line until the $9\frac{1}{2}$x$9\frac{1}{2}$ line is intersected, then follow, normal to the length lines, until the load line marked 100,000 lb. is intersected. Then by following parallel to the C lines the corresponding C is found to be about 1,375 lb. per square inch. If this is larger than the allowable, C, for the wood of which the column consists, the column is over-stressed.

Third: The length, the column, and the allowable, C, are given and the allowable load is desired. Consider an 18-ft. column, $9\frac{1}{2}$x$11\frac{1}{2}$ with an allowable, C, of 1,000 lb. per square inch. Follow along the 18-ft. length line until the inclined line marked $9\frac{1}{2}$x$11\frac{1}{2}$ is intersected, then follow parallel to the lines normal to the length lines until the 1,000-lb. C line is intersected and then read off the allowable load. In this case found to be about 78,000 lb.

Fourth: The load, the column and C are given to find the allowable length. Consider a $7\frac{1}{2}$x$7\frac{1}{2}$ column with a load of 55,000 lb. and an allowable, C, of 1,200 lb. Follow along the 1,200-lb. C line until the 55,000-lb. load line is intersected, then over until the $7\frac{1}{2}$x$7\frac{1}{2}$ line is intersected, then following parallel to the length lines the allowable unsupported length is found to be about 9 ft. 6 in.

Concreting Bridge Substructure in Zero Weather

All the concrete for the piers and abutment of the Independence, Ia., bridge, construction features of which were described in our Oct. 24 issue, was placed during the extreme cold weather of last winter, with temperature well below zero. As a consequence of the careful heating of materials and protection of the fresh concrete no damaged concrete resulted. The stone, sand and water were heated with steam and the forms were jacketed with 6-in. mat of straw and manure before the concrete was poured in them. Thermometer tests showed that the concrete was placed at a temperature of about 80° F. When the forms were removed after 10 days of temperatures ranging from 10 to 20° below zero, the concrete was still warm to the hand and steamed for several days.

Canadian Embargo on Iron and Steel Exports. A more complete embargo on the exportation of iron and steel products has been established by a Canadian order in council of Nov. 15. The following articles are placed under prohibition of exportation to all destinations abroad other than the United Kingdoms, British possessions and protectorates: Pig iron, steel ingots, billets, blooms, bars, and slabs, iron and steel plates, iron and steel shapes (comprising beams, channels, angles, tees, and zees), iron and steel fabricated for structural work and shipbuilding. Earlier embargo lists have included hematite, pig iron, iron and steel plates, and iron and steel fabricated for structural work and shipbuilding, all of which were prohibited to be exported to foreign countries in Europe and on the Mediterranean and Black Seas other than France, Russia, Italy, Spain, and Portugal.

Density Factor Safe Guide to Strength of Structural Timbers

Investigations conducted at the graduate laboratories of the Missouri Botanical Garden by Mr. Sanford M. Zeller, Research Fellow in the Henry Shaw School of Botany of Washington University, indicate that in the selection of high grade bridge materials of Southern pine, the density factor will not only be a safe guide to strength but also to decay resistance, provided sufficient restrictions as to sapwood are incorporated.

The experiments were made with three species of yellow pine, Pinus palustrus, P. echinata, and P. Taeda. Special attention was given to the physical properties of each sample of wood used, data being secured on (1) resin content, (2) specific gravity, (3) percentage of summer wood (the dark portion of the annual growth ring) or proportion of summer wood to spring wood in the growth rings, (4) the width of the growth rings or number of rings per inch measured on a radius of the stem, (5) sap and heartwood, and (6) the distance of the sample from the pith. The results of these experiments are set forth in a report by Mr. Zeller which is published as a bulletin of the American Raiway Engineering Association. The conclusions, derived from the investigation, follow:

(1) Resin is no safe index of the durability of the three species of yellow pine investigated. Resin is not only undesirable for specifying durability because it is no safe index of decay resistance, but also because of the expenditure of time and labor necessary to make resin percentage determinations.

(2) On the other hand, specific gravity or density of the wood materially influences resistance to decay of the heartwood, i. e., the more dense the wood the more durable it is, irrespective of the three species of wood examined.

(3) Specific gravity, however, is a property which can not be determined from inspection, but it can be estimated by recourse to the proportion of a summer wood to spring wood in the growth rings, which proves to be a safe criterion of the durability of heartwood; i. e., an increase in summer wood results in an increase in specific gravity.

(4) The width of the growth rings furnishes a further index of durability, the narrower rings showing more resistance to fungus attack than broad, open rings.

(5) The age, or distance from the pith of heartwood, shows no relation to durability, at least up to 16 in. in diameter.

(6) Sapwood decays irrespective of resin content, specific gravity, width of the annual rings, or species of pine.

(7) Shortleaf heartwood or loblolly heartwood is as durable as longleaf heartwood, provided it has the same qualities as to specific gravity or density.

(8) Specifications for durability of the three species of pine considered should be based on a judicious combination of specific gravity, number of rings per inch, and the percentage of sapwood. In other words, where pieces of the highest lasting powers are desired it will be necessary to specify pieces of the greatest density and with a minimum percentage of sapwood. For inspection purposes the specific gravity may be estimated by an examination of the percentage of summer wood. The more desirable pieces of timber are

those containing broad bands of summer wood and narrow bands of spring wood as shown in the cross-section.

(9) The investigations thus far have been conducted to ascertain the toxic effect of resin on the fungous decay of wood. The results have shown that there are no toxic effects, but that there are other important relations of resin to decay, as, for instance, its waterproofing effect on wood and, thus, its influence on the absorption of moisture by wood containing it; that is, the power of wood to absorb moisture is very important in its decay. It is well known that below a certain minimum and above a certain maximum of moisture in wood Lenzites saepiaria and other similar fungi will not grow. Any property of the wood which will influence this balance of moisture is of importance in decay resistance. Thus, if the wood contains enough resin to have a material waterproofing effect it must play a role in durability. However, at present the percentage of resin necessary for such an influence is unknown. From the analyses given above it may be assumed that it is at least 5 per cent or more, but this would not be a safe basis for specifying decay resistance, since a piece of timber of low summer wood percentage (density) may contain this amount of resin, and yet be porous enough to be attacked by fungi. On the other hand, although not an absolute rule, it is generally true that a dense piece of heartwood showing dark summer wood is more liable to contain at least 5 per cent resin than is a lighter piece. Hence, specifications based on high percentage of summer wood in most cases would more nearly fulfill requirements for durability than those based on resin content, at least until more is known concerning the influence of resin on the moisture-absorbing power of wood. The relation of resin to the absorbing power of pine timbers and the optimum relative humidity of the air for the decay of resin-containing woods are problems for further investigations. When this work is taken up again due consideration will be given to correcting the error due to sterilization. At a later time the probable error of the mean when dealing with averages of the above data will be calculated and reported with the data taken from cultures incubated for a 2-year period.

Breaking Up Reinforced Concrete Posts with Dynamite

Light charges of dynamite were used with success in breaking up reinforced concrete columns at the Colorado State College of Agriculture. The columns were 4 ft. square and 3½ ft. long and were intended originally for cores of ornamental posts. They were built with twisted steel reinforcing bars and conduit pipes for electric wiring were placed in the center. In addition to the rod reinforcing, there was an extra reinforcing of wiring in portions of the posts. In breaking up the columns it was necessary to use small shots because of the nearness of buildings—one structure being within 100 ft. of where the posts lay. The charge consisted of a ¼ stick of dynamite which was inserted in a hole drilled in the column. This method broke the posts to pieces so successfully that the reinforcing and electric conduits were removed intact without injury. The cost in labor for breaking up the posts was about $4 for all of the posts. To this labor cost must be added the cost of the dynamite. About eight sticks of dynamite were required for the whole job.

Fire Aids a Heavy Iron Ball in Wrecking a Modern Reinforced Concrete Building

By JOS. E. LOVE

Engineering Department, Chicago Union Station Co.

The necessity of demolishing a modern reinforced concrete building presented the wrecking contractor, who is clearing the site of the proposed headhouse of the new Chicago Union Station, with a rather difficult problem which was successfully solved by the use of a large cast iron ball aided by fire. With these the W. J. Newman Wrecking Co. has just completed the wrecking of the Western Newspaper Union Building at Clinton and Adams Sts., Chicago, and moreover, has produced a method effecting considerable saving of time and labor on this class of work.

In general the destruction of the concrete was accomplished by means of the cast iron ball, which weighed 1,200 lb. and was attached to a fall line running over the 40-ft. boom of a stiff-leg derrick. Difficulties of handling the derrick outfit between the building columns were lessened by equipping its 16 by 24-ft. platform with skids and rollers. A 25-H.P. Thomas direct-current electric hoist furnished the power not only for operating the wrecking machine but also for moving it. The contractor built the outfit for this particular job and assembled it ready for work on the roof in two days' time.

In operating, the slab of a floor panel was shattered by the ball until the reinforcement around the columns and beams could be cut with an oxy-acetylene flame. Then the ball, or "skull crusher," attacked the columns. By dropping it on the head of a column, the column concrete at the floor below for a height of 4 ft. above the base was split off from the column reinforcement on which the acetylene torch was used. At this point in the wrecking work fire was brought into use. In order to weaken the column sufficiently to allow its being pulled over with a line to the derrick motor, a wood fire was maintained around the column base for from 6 to 8 hours, after which the column was suddenly cooled with water. The resultant action of the sudden temperature changes was a further breaking and cracking of the column concrete. The efficacious work of the ball and fire rarely left any necessity for using hand chisels on the columns. However, on those floor beams acting as braces between the columns, the hand chisel was resorted to in cutting the connection to the columns, while the other beams fell with the columns. The fall of the columns and beams in most instances assisted the work of the "skull crusher" by partially shattering the slab on which they landed. After the wrecking outfit had worked its way to one corner of a floor it was lowered to the next floor on an inclined runway and completed the remaining panel from this position. That part of the brick facing of the building not knocked down by the jarring of the structure by the ball was removed with picks. The east wall of the building, entirely of brick, was knocked out by swinging the ball against short sections into which the wall had been divided by cutting vertical "V" shaped slots extending from one floor to another. The interior malacite partitions were easily removed by use of sledges.

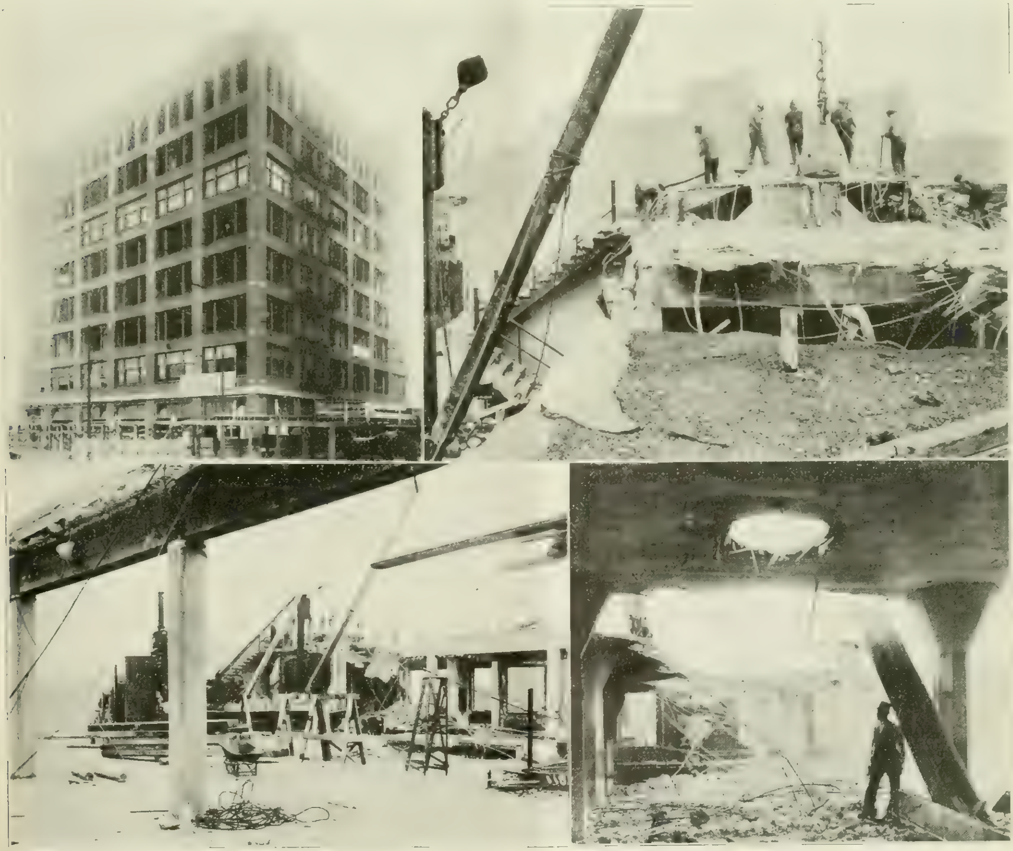
Five-ton Garford trucks hauled the broken concrete and other waste material away after it had been chuted to hopper bins over a driveway in the building.

On the upper floors the debris was conveyed to the chutes in wheelbarrows, but on the four lower floors the contractors saved approximately $40 per day in labor costs by using a team and scraper for this work. Only four of the 65 men engaged on the wrecking were required to operate the "skull crusher." The program of the contractor, which was followed very closely, called for the completion of the work in 10 weeks, allowing one week for each floor and two weeks for the basement where the hevy piers and columns were dynamited.

Scarcity of complete or extensive data on the costs of wrecking reinforced concrete buildings makes any comparisons difficult, and in making comparisons account must be taken of the present high cost of labor, a factor which is of great importance in this class of work, though here reduced considerably by the methods employed. The only figures available on the cost of this job was a recent estimate of $21,000 made by the contractor. Based on this figure, and not including the amount obtained from salvage, the cost of wrecking would be 15 per cent of the building's original cost of $175,000.

Ernest Schick, in "Der Abbruch von Beton und Eisenbetonbauten," states that 10 per cent of the cost of a reinforced concrete structure is sufficient to allow for wrecking. The contract for wrecking the Western Newspaper Union Building and the ten other buildings in the block bounded by Canal, Jackson, Clinton and Adams Sts. was let on a lump sum basis and secured by the Newman Co.'s bid of $49,800. Because of present market conditions the contractor was able to dispose of the 900 tons of salvaged reinforcing rods at a price which netted him much more than the total cost of wrecking the reinforced concrete building. The other buildings wrecked were brick or frame structures and ranged from one to nine stories in height.

The George Hinchliffe Co., Contractors, erected the Western Newspaper Union Building 8 years ago from the plans of Ritter & Mott, Engineers, and S. N. Crowen, Architect. The structure was eight stories in height and 107 by 120 ft. in plan, divided into panels 17 ft. 5½ in. by 19 ft. 4½ in. Designing live-loads of 250 and 300 lb. per square foot of floor area were necessary because of the requirements of the Western Newspaper Union, who occupied the building until recently with heavy printing machinery. The type of floor construction was not uniform, beams and slabs being used on six floors, and a flat slab system without beams on the other two. Floor beams were 16 in. by



Top Views: Old Western Newspaper Union Building, Clinton and Adams Sts., Chicago. Breaking Up the Roof with a "Skull Crusher." Bottom Views: Wrecking Outfit Completing Destruction of 8th Floor. Debris from a Demolished Floor; Hole Was Cut for Chute.

24 in. save for a few special ones, while the slab thickness ranged from 6 in. to 8½ in. All columns were hexagonal and their short diameters varied from 33 in. for the lower columns to 15 in. for those supporting the roof. The concrete was a 1-2-4 mixture with pebble aggregate, except for the 1-1-2 mixture in the columns. The plain round reinforcing rods of high carbon steel were ⅝ in. in diameter for the slabs, ¾ and ⅞ in. for the beams, and from 1 to 1½ in. for the columns, which were also hooped with a plain ⅜ in. round, pitched 2½ in. The results of the test of one of the floors, described in another article in this issue of "Engineering and Contracting," is indicative of the excellent condition of the building prior to the wrecking.

The 3,500 Ft. Embankment Approach to Hell Gate Bridge

A novel type of embankment was constructed for the eastern approach of the Hell Gate Bridge at New York City. This approach is 3,500 ft. long and consists of an embankment from 30 ft. to 65 ft. in height above ground. Seven streets are crossed by reinforced concrete arches which form a monolithic structure with the retaining walls of the embankment. A brief description of the embankment is contained in a paper by Mr. O. H. Ammann, presented Nov. 21 before the American Society of Civil Engineers, from which the matter in this note is taken.

The embankment consists of two longitudinal reinforced concrete retaining walls, connected and held in relative position by horizontal steel tie-rods, which are embedded individually in a shell of concrete for protection against corrosion. These rods resist the pressure from the earth fill. For additional stability, the two walls are connected by thin cross-walls, about 50 ft. apart. The arches consist of a comparatively thin barrel reinforced by vertical ribs. The fill is mixed clay, sand, and gravel, carefully placed in 12-in. crowned layers, and thoroughly tamped, so as to form a uniform compact mass, which exerts a comparatively small pressure on the retaining walls. It is thoroughly drained by chimneys of rock packing which extend along the walls from the top of the fill to the weep-holes at the bottom.

The walls and arches have perfectly plain surfaces and a simple coping. No attempt has been made at architectural treatment, because the territory in the vicinity is being built up mostly by industrial buildings which hide that portion of the railroad from prominent view. This embankment construction is considerably cheaper than the ordinary type, which consists of a fill between two independent gravity walls. For a height of 50 ft. the latter type would have cost from 30 to 40 per cent more.

A plate-girder viaduct with concrete piers, such as was used north of Lawrence St. and over the island, would also have been more expensive than the adopted type of embankment. For heights exceeding about 65 ft., however, the plate-girder viaduct became cheaper.

The embankment contains approximately 70,000 cu. yd. of concrete masonry, 160,000 cu. yd. of earth fill, and 1,000 tons of steel reinforcement.

The cost of construction per linear foot of embankment, inclusive of tracks, was approximately $470 for a height of 65 ft. and $280 for a height of 35 ft. (6.5 h — 50) dollars per square foot of elevation, h being the height of rail above the ground line.

Lump Sum Versus "Cost Plus" Contracts

An excellent summary of arguments, pro and con, relative to the "cost plus" form of contract was given by Mr. Fred A. Jones, president of the Fred A. Jones Construction Co., Dallas, Texas, in a paper presented before a State meeting of the American Society of Civil Engineers. An abstract of the paper follows:

Unless a close analysis, based on actual experience is made, the old style "lump sum" or "spotter" method of contracting, apparently has a great many advantages.

It is generally thought that the "lump sum" contract is a protection against graft, and especially in public work, due to the publicity given to the lettings, and because of the stringent clauses in the contract or specifications by which the architect or engineer becomes a representative of the owner, and closely watches to see that the contract is performed in all respects. Another supposed advantage is in the idea that the exact cost can be determined better in advance than by estimating, and further, the "lump sum" form of contracting enables the owner to avoid the embarrassment of selecting one contractor from among several, which at times, due to friendships or business reasons, might be awkward.

From the contractor's viewpoint there is a general feeling that more money can be made out of "lump sum" work than under the "cost plus" method, and the average contractor likes the gamble, because all savings that can be effected are his, adding just that much to his profits, whether these savings are effected by actual economy in operation, change of the market condition, change of plans (which usually brings added profits), or by obtaining especially good treatment from the inspectors.

While the "lump sum" contract undoubtedly causes more trouble and work and expense for the consulting engineer or architect, yet, he is apparently willing to undergo this on account of the apparent added importance to his position. This is more especially true of the narrow minded or inexperienced engineers or architects, but there are really big men, with ability, who still have the desire to put the contractor in a position of being obliged to cater to the owner's representative and his fancies.

The objections to the "lump sum" contract from the contractor's point of view, are not as commonly supposed, due to hazards, because the hazards can be reduced to a minimum, if the contractor has ample capital, a good organization, and never submits proposals without having a double checked estimate, with a reasonable margin of profit. I mean by a double checked estimate, two separate and independent estimates made by two estimators, and handed to the construction manager, who compares them and makes up his cost figures from his experience and the two independent estimates. Of course, the contractor should be able to use good judgment in the selection of architects, engineers and owners, with whom he figures, because it is very easy for unfairness on the part of those with whom he deals to cause him large losses, but the only real hazards, other than poor management, are the elements, unscrupulous or careless bidding of competitors and unfairness of architects, engineers or owners..

There is another hazard that can be reduced to a minimum by good judgment, and that is in the letting of sub-contracts, for it must be remembered that even though a sub-contractor has furnished a good and adequate bond, yet, if the sub-contractor fails, the owner is looking to the general contractor entirely, with probably a penalty for delay in completion. The general contractor cannot call on the bondsmen of the sub-contractor until he can show a loss and the amount of the loss, which can only be done at the completion of the job; when the time arrives to show the loss and collect from the bonding company, you very seldom collect any money on a bond of this character, for, in the desire to rush work to completion, more money will be paid to the sub-contractor than is due him, or the bond violated in some other way.

A serious objection from the contractor's point of view, to "lump sum" contracting is that no matter how much time and money he has spent on his organization, he is usually classed with any other contractor who can furnish satisfactory bonds. This is due to the lack of appreciation by the average layman of the fact that there can be a very material difference in the structure when completed, as between two different contractors, in spite of all reasonable inspection, although apparently the plans and specifications have been complied with in both cases. This lack of knowledge and experience on the part of the average layman makes it possible for bids to be received, at times, from those incompetent to do the work in hand. Naturally, it frequently happens that a good job is spoiled for a good contractor by unintelligent bidding of others, and is spoiled for the owner because he does not receive that for which he pays, and, in addition frequently has law-suits and other troubles in connection with his work. But this is not the most serious objection. There have been so many chances taken in the past, and so much "rule of thumb" method used in estimating, together with real and unavoidable losses, due to "acts of God" or other causes beyond the control of the contractor, that very few contracting concerns really have a good standing with the banks. Lack of sufficient funds, by reason of this poor standing, frequently causes a loss in what should be a profitable contract. It is impossible for banks to check an estimate and determine whether at the end of a job the contractor will show a gain or a loss in assets, and they are likely to withdraw credit at a critical time. In addition to this, if a contractor is bidding on all the work in his line which comes up in a certain territory, he is not likely to receive more than 1 out of 15 jobs bid upon, and the cost of estimating becomes a very large part of his overhead expense, as it is hardly possible to estimate, for example a $300,000 job at a cost of less than $500. The only estimate by any bidder that does anyone any good is that of the successful bidder; the balance of the money spent by other contractors on estimating is an economic waste. You can be very sure that the "lump sum" contractor does not forget this when he estimates his cost of a job (or if he fails to include it, he does not know his own cost), and the owner pays in the end; for like railroads, contractors are not Santa Clauses, and like other men, they have a feeling that no one is entitled to something for nothing.

From the viewpoint of the consulting engineer or architect, there are some real objections to "lump sum" contracting, for in the first place he increases his cost of supervision, which could be avoided by doing the work on a "cost plus" basis, and this is an economic waste. Furthermore, he is forced to look upon suggestions made by the contractor with a certain amount of suspicion, and the natural thought is, what advantage would the contractor making the suggestion obtain. In this way he loses a great deal of valuable assistance, because, even though he had confidence in the contractor, the owner, his client, might lose confidence in his expert advice if he were taking suggestions or receiving advice from one whose contractual relations were directly opposed to the interests of the owner. Again, contractors have been known to have some secret understanding among themselves, for this is sometimes done in spite of legislation against such practice. The modern first-class constructing and engineering organizations are the greatest enemies to "pooling," and the greatest friends to "cost plus" contracting.

Another natural objection of the architect or engineer is that he is not allowed to select an organization which to his mind, is the most efficient and can lend him most assistance, having some expert departments which he cannot afford to maintain. He must decide who the contractor shall be according to cold figures, knowing frequently in his own heart that it is not the best for the owner to accept the lowest bid, but fearing suspicion of the owner that he has ulterior motives if he recommends so highly some particular organization. In addition to this, in "lump sum" contracting there can be very little reciprocity as between engineer or architect and contractor. There is always a certain amount of give and take in any well conducted contract, but there exists no opportunity for the contractor to bring to the engineer or architect, a commission for professional services by reason of his influence with some particular client, or for the reverse, the architect or engineer to turn over without competition a job for which a certain construction organization is particularly well equipped.

From the owner's viewpoint there are many objections to "lump sum" contracting, some of which have already been covered. In the first place the contractor and the owner are not working along parallel lines. Their interests are not the same, and this cannot give the best results, though the contractor be ever so conscientious. Most all the objections already mentioned, of his engineer or his architect would apply so far as the owner is concerned, because of conflicting interests, but if such a contract were entered into as to allow him to select a highly developed and flexible construction organization, and encourage the most effective use of such an organization, all parties would be working toward a common end. Other objections of the owner are that if the architect or engineer makes and mistakes, thereby causing extras or, for any other reason, changes should be made, it is not to the interests of the contractor to call attention to these in advance of signing the contract, but rather to await such a time as the owner would be obliged to pay him almost his own price. Of course, any small changes can be covered by a clause in the specifications, but it is impossible to cover any very large change in orginal plans. The owner dares not pay the contractor more than is due, according to his contract, even though he may know that he cannot get efficient service without the contractor having ample funds, for he might in this way vitiate the contractor's bond. In fact, the whole proceeding must be bound around with a large amount of red tape.

How much better, how much simpler, and how infinitely more to be desired, is a form of contract where the contractor, owner and expert are working in absolute harmony? Under such a contract, harmony exists because their interests are the same, and they practically form a partnership for a time. The "cost plus" contractor receives the wages of trust, and it goes without saying that there must be absolute integrity and efficiency in the organization before it is wise to deal with a contractor on any basis, but, being first satisfied with the contractor's organization and character, the advantages of the "cost plus" method are:

First, the rate of profit being fixed in advance the owner and contractor are in position to work together for the very best results for the money to be spent. Their interests do not conflict.

Second, desirable changes that arise during construction (and some always arise) can be made in exact equity to the owner.

Third, it should give an owner a better property—the best he and his engineer or architect and contractor can produce for the money spent, at a lower profit than he would usually pay on a flat sum basis—anyway not exceeding cost, plus a reasonable pre-agreed profit, which is as cheap as he is entitled to it; and,

Fourth, the work can be started immediately without waiting for completion of plans in all their details.

In a "cost plus" contract, the owner also receives the savings made in purchases, which are effected by studying conditions as requirements arise for materials, and here is opportunity for considerable saving, sometimes equalling in amount the entire fee of the contractor.

A reliable estimate of the eventual construction cost made by a well organized and experienced contracting concern is a better guide for the owner as a rule than the bidder's figures on a "lump sum" contract letting. One of the most satisfactory methods of limiting the cost is to let all parties know in advance this limit and work in unison not to exceed it, but to get the most for the money spent, while to try to limit the cost by requiring a guaranteed maximum is only getting back to the red tape of the "lump sum" contract without gaining anything.

In conclusion, a "cost plus" contract is a bankable piece of paper.

Portable Houses for American Troops in France.—It is expected that contracts will be let shortly for 300,000,000 ft. b. m. of Southern pine for portable knock-down houses for the use of American troops in France as hospitals and barracks quarters. Plans prepared by War Department architects provide for houses to be made up in panels, put together by bolts, shipped knocked-down, and bolted together by soldiers in France.

Barracks for Housing Workmen for Ship Yards.—The American International Shipbuilding Corporation has started construction on the erection of barracks at the ship yards on Hog Island, on the Delaware River, for housing 30,000 men. The barracks will be patterned after those erected by the Government in accommodating its soldiers in the various cantonments.

City Manager for Norfolk, Va.—At an election November 20 the citizens of Norfolk, Va., by a majority vote of 2,184, adopted a new city charter, which provides for a council of five members and a city manager.

Shear Diagram for Bentup Bars

By FRANK S. BAILEY,

With Metcalf & Eddy, Consulting Engineers, Boston and Chicago.

The determination of the value of bent up bars in providing for diagonal tension in reinforced concrete beams is considerably simplified by the use of the diagram here shown. The Joint Committee formula for the area of steel section in each bend (of 20° to 45° with the horizontal) is

$$As = 2/3 \text{ x } \frac{3/4 \text{ V S}}{\text{fs j d}} \text{ in which}$$

As = area of section of steel in bend
V = total vertical shear
s = horizontal spacing of bends
fs = unit stress on steel
j = ⅞ (average value)
d = depth to center of steel.

This formula is based on the assumption of two-thirds of the total shear being taken by the steel and one-third by the concrete. The Committee recommends that, s, be not greater than ¾ d. Now placing s = ¾d in the above equation and solving for, V, we obtain the following value:

$$V = 7/3 \text{ As fs;}$$

and making Fs = 16,000 lb. per square inch—

$$V = 37{,}333 \text{ As,}$$

from which equation the diagram was plotted.

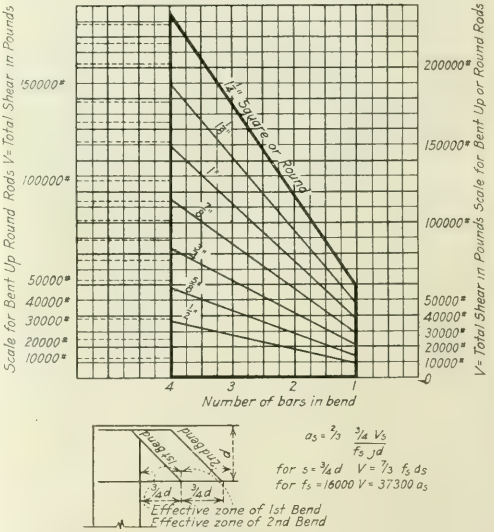


Diagram Showing Sizes and Numbers of Bent Up Bars or Rods to Provide for Various Values of V = Total Shear, When the Horizontal Spacing Is ¾d, and Concrete Takes ⅓ of V and fs + 16,000.

Assuming that one 1-in. square bar is bent up, As = 1.00 and the total amount of shear provided for is 37,333 lb. If there are two or three bends, each bend consisting of one 1-in. square bar, and the bends are spaced horizontally, a distance equal to ¾d, then each bend provides for 37,333 lb. shear on the section of the beam where the bend is effective. If the spacing should be twice as close or equal to ⅜d, the shear provided for would be double the above amount, or about 75,000 lb.; if four times as close, or equal to 3/16d, it would be about 150,000 lb. It has been the practice in the past few years, in some offices at least, to provide a sufficient number of vertical stirrups to take care of the shear and regard the bent-up bars, if there were any in the beam, as an additional factor of safety.

In competitive designs where it is necessary to prepare as economical an arrangement of steel as possible, there is a tendency to save stirrups by allowing for the value of bent-up bars. In cases where the bent-up bars do not provide sufficiently for the total shear, the spacing and size of stirrups to make up the difference may be found by the following formula;

$$s = 3/2. \frac{As\ fs\ j\ d}{V - V_b}$$

in which V_b is the shear provided for by the bent-up bars, the other symbols being the same as in the formula previously quoted.*

The Joint Committee suggests that the tension due to bending moment at the point of bending, should be considered. The diagram gives the full value of the bent-up bars with nothing deducted for tension from moment. As the tension varies in different cases, they should be considered separately. In a beam with 4 bars, 2 of which are bent up at a point where the moment is half of the maximum and where the tensile stress in each of the four bars is 8,000 lb. per square inch (the maximum being taken at 16,000 lb.), it is evident that to allow for this we must deduct 8,000 lb. per square inch, caused by bending moment, from the 16,000 lb. per square inch to which the total stress is to be limited, leaving 8,000 lb. available for diagonal tension. In that case the value of the bent-up bars would be but half the value given by the diagram (which is based on fs = 16,000 lb.). In the case of the two ¾-in. square bars they would take care of only 21,000 lb. of shear instead of 42,000 lb., as read from the diagram. If there were only 4,000 lb. tension due to moment, there would be 12,000 lb. or ¾ of 16,000 available for diagonal tension, so the two ¾-in. square bars would take care of ¾ of 42,000 lb. or about 31,000 lb. of shear.

Government Subsidized Steel Plant Proposed for Holland.—A meeting of interested parties, at which the Holland government was represented has just been held to consider the creation of an important new enterprise for Holland—a smelting furnace and a steel and rolling mill. A joint stock company is contemplated with a capital of $10,050,000, of which the government, if the parliament approved, would take about a third. The plant would be at Ymuiden, at the entrance of the North Sea Canal, and therefore at a most convenient spot for imports of raw materials.

City Will Vote on Conducting Municipal Fuel and Ice Plants.—A special election will be held at Oshkosh, Wis., on Jan. 8 to decide whether the city shall conduct municipal fuel and ice plants.

The city of Kansas City, Mo., is calling for bids for constructing a viaduct involving a main structure 900 ft. long of reinforced concrete and a steel approach 460 ft. long.

The Greatest Arch Bridge in the World and Its Cost

The Hell Gate arch bridge, which carries the four tracks of the New York Central Railroad over the East River in New York, is the longest arch bridge in the world, its span being 1,017 ft. between abutment faces and 995 ft. between centers of bearings. The clear width between the two trusses is 53 ft., the distance from center to center of trusses being 60 ft. The cost of the bridge, exclusive of approaches, was about $3,700,000, distributed as follows:

Towers and foundations	$1,700,000
Steel superstructure	1,900,000
Concrete flooring and ballasted tracks	100,000
Total	$3,700,000

This is equivalent to about $68 per square foot of floor area.

There are 110,000 cu. yd. of masonry in the towers and foundations, and 19,400 tons of steel in the superstructure, distributed as follows:

	Pounds.
Stringers	4,010,000
Floor beams	3,870,000
Railing girders with wind chords	635,000
Floor laterals and bracing girders	575,000
Total floor system	9,090,000
Arch trusses	21,640,000
Floor suspenders	1,380,000
Arch bracing	3,670,000
Bearings	1,990,000
Total steel weight	37,770,000

or an average of 37,000 lb. per lin. ft. of bridge. This does not include 170 tons of I beams in the concrete floor-slabs.

The average dead load is 51,000 lb. per foot of bridge, inclusive of the solid ballasted floor. The bridge was designed to carry Cooper's E — 60 loading.

The steel cost about 5 ct. per pound in place. The erection of the arch was begun in September, 1914, and was finished two years later, with an average force of 140 men.

In a paper 190 pages long, presented Nov. 21 before the American Society of Civil Engineers, by O. H. Ammann, many interesting details of this great bridge are discussed. Its designer, Gustav Lindenthal, selected the arch type in preference to the cantilever and the suspension types. The estimated weight of carbon steel in an arch was 13,000 tons, as compared with 14,000 tons for a suspension and 17,000 tons for a cantilever bridge.

Speaking of the selection of the type of bridge and of the arch, cantilever and suspension types of bridges, Mr. Ammann says:

> The span length, required clearance; character of soil, and other local conditions at Hell Gate are such that, in a broad sense, there is little if any difference in cost between the several types mentioned. Whatever differences in cost may be found by comparative designs are largely due to the individual judgment of the designer in the selection of the truss system, material, permissible unit stresses, foundations and architectural features.
>
> A real economy of the suspension type over the others comes in with spans greater than 850 ft.; an appreciable economy of the arch over the cantilever and suspension types would have been realized with more favorable configuration and character of ground, particularly if the required clearance had permitted the same span length for the arch as for the other types. There was the more reason, therefore, for selecting the type for the Hell Gate bridge on broader than mere economic principles.
>
> Mr. Lindenthal conceived the bridge as a monumental portal for the steamers which enter New York Harbor from Long Island Sound. He also realized that this bridge, forming a conspicuous object which can be seen from both shores of the river and from almost every elevated point of the city, and will be observed daily by thousands of passengers, should be an impressive structure. The arch, flanked by massive masonry towers, was most favorably adapted to that purpose. * * *
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> The three-hinged arch was not considered. It is not cheaper than the two-hinged arch, and is not as rigid. The fact that the

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*Diagrams prepared by the writer for finding the spacing of ¼-in., ⅜-in. and ½-in. square stirrups, based on the above formula, were published in Engineering News, Oct. 12, 1916, and have been reprinted in a Lefax notebook sheet.

two-hinged arch is statically indeterminate is frequently cited as an objection to that type. This is not justified. There is no more uncertainty in the stress distribution in that type than in a so-called statically determinate structure with riveted connections, and even pin connections do not remove the uncertainty, as is now well recognized. Moreover, if desired, it is always possible, as has been done in the case of the Hell Gate bridge, to erect the two-hinged arch so that it is statically determinate for dead load. This, however, is a convenience in erection rather than an advantage as regards stress action. Of course, the above characteristic of the two-hinged arch is a serious objection where no solid foundations can be obtained, because of the uncertainty of stresses which may be produced by a spreading of the foundations. A two-hinged arch required unyielding abutments.

The First Reinforced Concrete Motor Boat on the Great Lakes

A reinforced concrete motor boat, the only one of its kind on the Great Lakes, has been presented to the Naval Reserve by Mr. Walter N. Dowsey, the owner and builder of the boat. The boat was constructed at Iron Mountain, Mich., in 1914, and has been in constant use for the past three years.

It was built up with a T-bar laid for the keel, the end of which was turned upward and used for prow post. Flat steel 12 gage by 1 in. was riveted to the keel as ribs on 12-in. centers. Some flat steel strips, 12-in. centers, were then riveted to the ribs extending lengthwise from prow to stern. Upon this light framework of flat steel 12-in. strips of ¼-in. square wire mesh were attached by wire, covering the entire hull, one thickness; below water line and on the bottom, two thicknesses were used.

Motor Boat Constructed of Reinforced Concrete.

The concrete was applied with a trowel and in order to complete the work the owner worked until midnight. In the morning he discovered that the cement had dried too rapidly and showed some hair cracks. The hair cracks have received no attention to date and have caused no trouble. No effort was made to trowel the outer surface of the hull smooth and as a result it is not a real speedy boat, though it easily makes 10 miles an hour. The concrete was allowed to harden under cover and was sprinkled during the hardening.

The boat is 18 ft., 6 in. long; has a beam of 4 ft. 6 in.; thickness of hull ¾ in.; depth of hull, 38 in.; power, 6-H.P. motor. Portland cement and sand were used in proportions of 1 part of cement to 1½ parts of sand.

"Cost Plus" Contract Forms of Stone & Webster

Stone & Webster, one of the largest construction firms in this country, carries out nearly all of its contracting work under the "cost plus" form of contract. Four forms of contract are used by this concern: (1) Percentage basis for design and construction; (2) fixed fee basis for design and construction; (3) percentage basis for construction alone, and (4) fixed fee basis for construction alone. The main features of these forms are practically identical, and accordingly only the one for "construction alone on the fixed fee basis" is reprinted below. The points of difference in the forms are shown by the footnotes.

Stone & Webster Form of Contract for Construction Alone on Fixed Fee Basis.

.... 19..

....

....

We hereby propose to construct[*] for you

I. SERVICE TO BE RENDERED.[†]

With respect to this work we propose to act as your own Construction and Purchasing Departments, being guided in all respects by such instructions as you may from time to time give us.

As Constructors, we will execute with our own forces the construction and install the machinery and equipment, sub-letting parts of the work when it is to your advantage to do so, and turn the completed work over to you ready for regular use.

As Purchasing Agents, we will purchase the necessary machinery, equipment and materials.

We will furnish at our own expense:

(a) The service of the members of the firm and the executive officers of the Division of Construction and Engineering, who will direct and oversee the work performed under this agreement.

(b) The service of an Assistant Construction Manager and the Construction Department in the Boston office.

(c) The service of the Purchasing Department in our Boston office which will assist in the purchase of the machinery, apparatus and materials.

(d) The service of the Accounting and Auditing Departments in our Boston office.

(e) All other expense of our Boston office, excepting only the salaries of men in the Engineering and Drafting Departments for the time they are engaged on your work.

II. COMPENSATION.[**]

You are to pay us for the services specified above the sum of $..........

This amount is payable in instalments of $........ on the last of each month, commencing with

19.., until 90 per cent of the total is paid, the balance of 10 per cent being payable on completion of the work.

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[*] In the contracts for design and construction this sentence reads: "We hereby propose to design and construct for you."

[†] The first two paragraphs under "Services to be Rendered" in the contracts for design and construction are as follows:

"With respect to this work we propose to act as your own Engineering, Construction and Purchasing Departments, being guided in all respects by such instructions as you may from time to time give us."

"As Engineers, we will make all necessary studies and determinations, recommend to you the type and character of equipment and of construction required and prepare plans and specifications for equipment, material and construction work."

[**] The compensation clause in the percentage basis contract is: "II. Compensation. You are to pay us for the services specified above a sum equal to .. per cent of the 'cost of the work,' as defined in the next section, payments to be made at the end of each month based on expenditures during that month."

If material change in the scope of the work is ordered by you there shall be added to or subtracted from this amount a sum equal to ...... per cent of the estimated cost of the work added to or deducted from that now contemplated.

III. COST OF THE WORK.

It is understood that "cost of the work" shall include the following items whether commitments or expenditures are made by you direct or by us for your account:

(a) The cost of all materials, machinery, equipment and labor.

(b) The cost of any lands or rights of way required.

(c) The cost of tools and construction equipment purchased and the rental of any equipment hired.

(d) The cost, at salary rates, of men in the Engineering and Drafting Departments in our Boston office or in the field in connection with any engineering or designing we may be called on to do, with the choice and purchase of materials and apparatus and with the inspection of the work.

(e) The cost of a works office, including the salaries and expenses of a superintendent of construction, an accountant, a purchasing agent, and such assistants as they may require; the cost of all field engineering and inspection; the expense of maintaining the works office.

(f) The cost of insurance and any expense incurred in connection with any accident or damage to person or property.

(g) Any traveling expenses or expenses of a similar character and any other expenditures we may except for items specified in Section I, as furnished at our own expense.

IV. DISBURSEMENTS.

We will make all payments for material, labor, equipment, services, etc., for your account from funds to be advanced to us by you for the purpose, giving you each month a detailed statement of expenditures during the previous month, supported by proper vouchers.

V. PURCHASES AND CONTRACTS.

You will have as full control as you care to exercise of the purchase of materials and equipment and of the letting of such sub-contracts as may seem desirable.

All contracts and orders placed by us, payrolls and other obligations, shall be in your name, "By Stone & Webster, Agents," and it is understood that we assume no pecuniary liability under or by reason of such obligations.

VI. INSURANCE.

Unless otherwise directed by you, we will place insurance in your name and for your account, covering your liability to the public and to employes engaged on this work, with limits of $10,000 for any one person and $20,000 for any one accident, unless Workmen's Compensation laws make it advisable to secure insurance in some other form or amount. The policies will be in the usual form.

If you so request, we will place insurance in your name and for your account covering damage to the work, or any part of it, by fire.

VII. PROGRESS REPORTS.

We will render reports to you monthly showing the progress of the work in its various parts and any changes that it may seem advisable to make in the estimates of cost or of time required for completion.

VIII. AUDIT.

Our correspondence, records, vouchers and books of account, in so far as work done or money expended under this agreement are concerned, will be always open to your inspection.

IX. TERMINATION OF EMPLOYMENT.[††]

If at any time you should become dissatisfied with the manner in which the work is being conducted, or should wish, for any reason, to discontinue the work, you are at liberty after ten days' notice in writing, to terminate our employment and to take possession of the work done and material furnished for you under the terms hereof.

In case you take such action, we shall be entitled to receive in payment for our services, all instalments due us under the terms of Section II, including that for the month during which such termination occurs.

X. ACCEPTANCE AND APPROVAL.

On acceptance of this proposition by you, and its approval by Stone & Webster it will constitute an agreement between us.

The advantages of the "cost plus" form of contract is summarized as follows by Mr. H. L. Rogers, Manager of the Division of Construction and Engineering of Stone & Webster:

> The advantage of either the percentage or fixed fee over the lump sum basis for work of any magnitude are so obvious that it is difficult to understand why the old basis can persist. The adoption of the percentage basis by the Government for a large part of its work in this present emergency is a very strong endorsement and undoubtedly will be accepted as such by most people having important work to do. As a matter of fact, almost every sizeable construction job is about as much of an emergency for the man putting up the money as these Government works are for the Government.
>
> The principal advantage from the owner's point of view is that the construction force works for him in precisely the same way as his architect or engineer works for him, and can meet any contingency in material or labor markets from the owner's point of view, and from his only. Of course, there are small jobs extending over a short period of time and of such a character that the cost can be pretty accurately determined in advance where the lump sum basis will produce satisfactory results, but in work of any importance where all details can not be determined in advance or where material for the whole job can not be purchased before the contract is signed, the contractor is taking a big gamble for which he tries to get adequately paid.
>
> The argument most frequently made against this basis is that the contractor has no incentive to keep costs down because his own bank account does not suffer by any extravagance. As a matter of fact, the cost of any sizeable development depends more on the design, that is, the plans and character of the material specified, than it does on the method of execution or variations in cost of the particular materials, so that the work of the engineer or architect usually has more to do with the cost of the job than the work of the contractor, but for some obscure reason it is not felt necessary to compel them to work on a lump sum basis or to give them any cash incentive to make a design that will result in the lowest feasible cost.
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> Architects or engineers are considered as professional men who can be trusted to give conscientious and disinterested service to their clients, and I believe that public sentiment is gradually swinging around to such a point that contracting concerns can be considered in the same way. It is perfectly obvious that an owner is to a large extent in the hands of his architect and builder as to the total cost of his development, and that he must be as careful in the choice of a contractor as he is in the choice of an architect. In other words, an owner should not retain a contractor on a fee basis unless he has good reason to feel confidence in his integrity and ability any more than he can entrust his designing work or his legal or any other professional work to any one whom he does not have confidence in.

[††] The first paragraph of this clause is the same in all contracts. The second paragraph, however, under the percentage basis form, is as follows:

"In case you take such action, we shall be entitled to receive in payment for our services, the specified percentage on the total sum of actual expenditures, accounts due and payable, outstanding obligations, and uncompleted contracts and orders as of the date of such termination."

Comparative Designs of Plate Girder Viaducts

The approaches to the Hell Gate Bridge at New York City include about 10,800 lin. ft. of plate girder viaducts with concrete piers. The considerations governing the selection of the design for these structures were outlined by Mr. O. H. Ammann in a paper* presented Nov. 21 before the American Society of Civil Engineers, from which the note following has been abstracted:

Typical portions of two preliminary designs for the plate girder viaducts and the design adopted are shown in Fig. 1. The top drawing (a) represents the typical American trestle viaduct with alternate tower spans, 40 ft. long and intermediate spans of 80 ft. This type, the advantages of which were cheapness and rapidity of erection, is now gradually being displaced by types of greater rigidity and durability, and better appearance. It would have been inappropriate and inadequate for the approaches to the Hell Gate Bridge. The drawing (b) (Fig. 1) represents the design made by Gustav Lindenthal in 1906. It consists of plate girders, of nearly uniform span length of from 70 to 80 ft., resting on steel rocker bents. To resist the longitudinal forces from braking and traction solid masonry piers (stability piers) were to be provided about every tenth span. This design is superior in general appearance to the trestle design. The stability piers convey the impression of rigidity, and give opportunity for architectural treatment. The arch form selected for the steel rocker bents, although somewhat more expensive, is more pleasing than the ordinary two-column bent with single intersection diagonals. This type of viaduct is also stiffer, in the longitudinal direction at least, than the trestle type. The design (c) (Fig. 1) represents the type finally adopted, with concrete piers. It is superior to the other two types in appearance, rigidity, and durability, and is less costly to maintain.

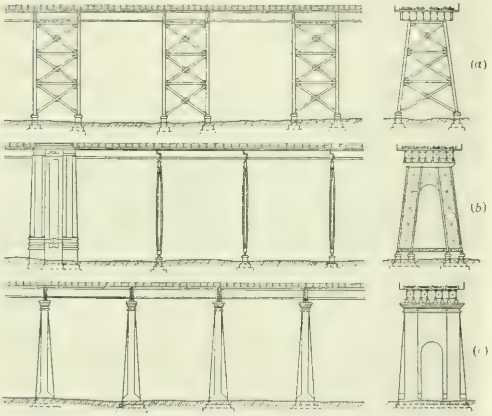

Fig. 1—Designs for Plate Girder Viaduct Approaches to Hell Gate Bridge.

A comparison of estimated costs, with the prices prevailing at the time the design was made, showed that, for an average height of viaduct of 100 ft. on tangent, the steel trestle design would have been about 20 per cent cheaper, and the design with steel rocker bents about 10 per cent cheaper, than the adopted design. On a 3° curve the saving in first cost would have been only 15 per cent and 5 per cent, respectively, as the centrifugal force of the trains requires additional material in the steel bents and towers, but not in the masonry piers. For heights of viaducts of less than 100 ft., the differences in cost are correspondingly less. With the high prices of steel prevailing at present, there would be little, if any, saving in favor of the steel trestle type.

The arched concrete piers mark a radical departure from the ordinary solid square concrete piers with plain surface and simple square coping. The rectangular body of the pier proper is only 6 ft. thick, from the coping down, but is reinforced by four buttresses which have a batter of 1:15. These piers convey the impression of elegance and yet of great rigidity. The appearance is enhanced by the massive and architecturally elaborate coping of cornices and mouldings.

The concrete is made of 1 part portland cement, 2 parts sand and 4 parts gravel or broken stone, and is reinforced with steel rods, vertically and horizontally, against shrinkage and temperature cracks.

Rope Saving Guy Anchorage

In the use of derrick or tower guys it is common experience that the least deterioration occurs while the guy is in active service. The usual cause for discarding guys is kinks made by fastening the rope around anchor devices that are too small. Perhaps the worst wear that falls upon the guy in actual use is caused by the rotting of the core when the guy is fastened around a deadman and covered with dirt. A recent issue of the "Crosby Clipper," a publication of the American Hoist & Derrick Co., contains a description of a rope saving guy anchorage that has been used successfully, on a number of derrick installations. In this the sheave and clevis are fastened to a piece of well-greased scrap cable fastened to the deadman, eyebolt or stump. When the derrick is moved the kinks or rotted core, or both, will be in the piece of scrap, not in the guy.

A Type of Anchorage That Saves Guy Ropes.

This method of fastening makes it very easy to tighten a guy, for the sheave aids instead of retarding the process, as is the case with most fastenings. It promotes safety by keeping guys in good condition, and removes the temptation to use guys after they have become kinked.

Plans have been completed for rebuilding the principal business district of Bergen. Some 369 buildings in this district were destroyed by a fire on Jan. 15, 1916, causing a loss of $10,000,000 to $20,000,000.

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*The Hell Gate Arch Bridge and Approaches of the New York Connecting R. R. Over the East River in New York City. Proceedings Am. Soc. C. E., Vol. XLIII, pp. 1651-1841.

The War's Effect on Merchant Shipbuilding*

The exponent in an official way of the theory of building the maximum number of ships is the United States Shipping Board, with the Emergency Fleet Corporation as the largest individual owner and builder of merchant ships anywhere, either at this time or at any other time in the history of the world. All of the shipbuilders have had their new ships commandeered by the Shipping Board, and these ships are now being pushed to completion under the direction of the Shipping Board. In addition to the ships under construction at the time the Shipping Board took over all these vessels on Aug. 3 last, the Shipping Board has placed contracts for 200 to 300 additional steel ships and for about 200 wooden and composite ships. The English have built ships at a very rapid rate during the past six months, but prior to that time their capacity has fallen off woefully. The figures of British shipbuilders are that in normal years their capacity in tons was about 2,000,000. In 1915 they built only 700,000 tons. In 1916 only 550,000 tons. In the first six months of 1917 they built 500,000 and by the end of 1917 they will have built during this year almost 2,000,000 tons, or practically their normal tonnage.

In comparison, it is interesting to look at our record, which is mostly in the future. The largest tonnage ever built by us in any year prior to the present year was in 1908, when we built 615,000 tons. In 1917, or at the end of the fiscal year of 1916-17, on July 1, the total tonnage turned out in merchant ships in this country was close to 800,000 tons. Of course we expect that that will be bettered very much, and the production, except for labor difficulties, would have been very much greater than that; but it is a far cry from 800,000 to 1,000,000 tons of ships a year to a prospective 2,500,000 to 5,000,000 tons of ships a year, and especially when we consider that the best the first shipbuilding country of the world ever did in any one year was only 3,000,000 tons.

There is an idea extant that if a ship is called "fabricated" or "standardized" it becomes rather easy to build. It does become easier to build, but it is not any easier to drive a rivet in a fabricated ship than in a common ship, and the 7,500-ton fabricated ship will have about 650,000 rivets and some riveters must do a considerable amount of work to drive those rivets in that ship the same as in any other ship. The most onerous work in building a ship is in the driving of the rivets; and, if any concern is going to build one ship a week, it must drive 650,000 rivets a week. When we consider that the best rivet drive is by the Union Iron Works, where they drive 250,000 rivets a week, and the next best by the three largest shipyards on this coast is about 200,000 rivets each per week, the problem of driving 650,000 rivets a week assumes a rather difficult aspect to the casual observer. Still, we all hope it will be done, but if it is done it means the importation of an enormous number of new workers into the industry.

The fabricated ship has the center of the stage at the present time. In England a standardized ship was adopted which is very much like a fabricated ship, and they are being turned out at a rapid rate. The first ships have already been completed and are on the sea now, if indeed they have not already arrived in this country. The fabricated ship, like the English standard ship, has the disadvantage of low speed, and at the same time it has the advantage of a large carrying capacity. The records of submarine sinkings, such as have been gathered, indicate that speed is probably the safest defense against the submarine. The number of very slow ships sunk is very great in proportion to the number attacked. Probably 90 per cent of the slow ships are sunk when attacked by a submarine. As the speed becomes greater the immunity of the ship from torpedo attack becomes greater—not only because she presents a more difficult target, but also because the vessel may run away from the submarine in darkness or in daylight if she has a greater speed than the submarine has on the surface, and also because the vessel may be maneuvered much more quickly. One of the most gratifying things about submarine warfare is that the torpedoes are not making the speed as in the early days of the war. The speed of the torpedo has undoubtedly become much decreased. Just why we do not know, although it is probably due to the absence of tungsten and manganese and some other ingredients now so difficult to obtain in Germany. Vessels of 16 or 17 knots have actually dodged the torpedoes.

The vessel of 16 or 17 knots is also needed to carry soldiers. We are shipping all our soldiers to Europe in vessels 14 knots or over because it is thought to be too hazardous to ship them in the slower vessels. We have at the present time in this country enough vessels in commission to ship soldiers to Europe at the rate of not more than 1,000,000 a year. That includes all vessels of 14 knots or over. But by building a large ship as well as a speedy ship an additional factor of safety is obtained, which may be illustrated by stating that a torpedo will blow just as big a hole in a little ship as a big ship. When a small, short ship has a large hole in it a relatively larger proportion of its length is open to the sea. When a similar hole is blown into a long ship a very much smaller proportion of that vessel is open to the sea. So that it is perfectly possible to design, and practical, indeed, to design, a ship of 500 or 600 ft. long, so subdivided that it will take two and probably three torpedoes of the German variety and still stay afloat. The design, however, must be of such character that when the compartments are flooded the ships will still remain upright. The requirements of passengers who go to sea are such that the ordinary passenger ship shall have a very small metacentric height. But with a small metacentric height the rolling of the vessel is very easy, so that the passengers are not made ill with the motion of the ship as easily as they would be if there were a large metacentric height and the ship rolled quickly and with a jerk. The ordinary passenger ship is modeled with a small metacentric height, and three-fourths of them, when bilged or torpedoed, will probably turn over before sinking.

The larger type of ship which will probably be built before the war is over by a number of concerns in a position to undertake this work will be designed with a high speed for troop transport, with a close subdivision to make the ship safe, and with a large amount of stability so that the vessel will also be safe against turning over.

The war so far has developed, or called attention to, three distinct types of vessels: The standardized or fabricated ship like both the English and the United States have adopted, the large troop transport which has been described, and, in addition, the submarine chaser.

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*From an address by Homer L. Ferguson, President Newport News Shipbuilding & Dry Dock Co., delivered Oct. 16 at a joint meeting of the Engineers' Club of Philadelphia and the Philadelphia Section, American Society of Mechanical Engineers.

In addition to these three types of ships brought out by the war, there has been a very definite attempt to rejuvenate what some of us have considered a dead industry. We have a few of the older wooden ship builders left, but the building of a wooden vessel to my mind is so much more difficult than the building of a steel vessel and requires so much higher skill than does the building of a steel vessel that I wonder how they can ever expect to build them.

I do not believe that a 288-ft. wooden ship built in a lumber yard, either south, west or north, and necessarily by men who are not expert ship carpenters, will ever relieve any great distress on the other side of the water, caused by lack of fuel or food. On the other hand, these vessels may be used in our own trade at home. My chief regret is that they are not made shorter, because when such ships are over 200 ft. long it is rather difficult to hold the ends up. If we get more vessels through building wooden ships, let us build them, but it is unfortunate that the type was settled before many professional wooden ship builders were on the job. The wooden ship builders of course have taken a good many men from the steel shipyards and have lessened production to just that extent; but, on the other hand, they will add a very considerable tonnage, now that practically all our large coastwise ships are either going abroad or are in the way of being commandeered for foreign service, so that the wooden ship will serve a useful purpose.

The standard ship probably offers the best opportunity for a large increase in our tonnage. The standard ship has been built on the Great Lakes for years. On the coast, with the coal trade, there has been some effort toward standardization. With the standardized ship the main benefit is not in the hull of the vessel, or in the fabrication of the vessel in the steel mill. The main benefit is that the machinery and the outfit, the winches, the pumps, the steering gear, the engines and boilers and all the thousand and one things that go into the ship are standardized and may be produced in large quantities at some point other than the yard of the builder. The standardization of the fittings of a vessel are more important to my mind than the standardization of the hull. The amount of money saved in the latter will be the money to build the templets, patterns, etc., amounting to not more than 12½ to 15 per cent of the labor cost of the hull. We are told, too, that all the riveting will be done at the steel mills. It probably will not and if 20 per cent is done it will be more than I think will be done unless the railroads will carry pieces of steel as large as this auditorium.

Shipyards have naturally tried to standardize within their own practice the fittings that go on the various ships they build, and a great step is being made in that direction by one of the largest corporations in the country. The Bethlehem Company owns so many shipyards that it is in a position to standardize as between its various yards, with the result that there will be considerable saving in cost and in time in the production of all the things that go into a ship. But in building the standardized ship, or in building any other ship, the real problem is not the problem of equipment; it is not the problem of money even; it is not, except in part, the problem of location, but it is the problem of men. A very simple lesson in arithmetic will indicate that if 100,000 rivets are to be driven in one day and any one gang of riveters will drive 300, then it will take so many men and boys and helpers to get that drive.

On the Delaware and on the Chesapeake, which we, on the Chesapeake, are pleased to consider the two largest shipbuilding communities in the United States, there are at present about 32,000 men employed in the shipyards. There could be employed to advantage in these same yards at this time a total of 48,000 men, and within the next six months, or the next nine months at the latest, these same yards, barring the fabricated shipyards, could employ to advantage a total of 60,000 men. So the problem becomes arithmetical again. You have 32,000 men working. To get the maximum production out of the shipyards already in existence you will need to use 60,000 men. Where are the 28,000 extra trained shipbuilders to come from? Add to that the fabricated shipyards, which on the Delaware will probably require 20,000 men, and in the vicinity of New York an extra 10,000, and we have in this immediate district need for approximately 60,000 new mechanics in the shipbuilding business. According to Admiral Capps, there will be needed in the whole United States in shipbuilding within the next six months an additional 150,000 men.

The "Cost Plus" Form of Contract Used on Cantonment Work, Including a Schedule of Equipment Rental Rates

Engineers who are contemplating the use of some form of "cost plus a fee contract" will undoubtedly find much of interest in the form of government contract for contract for cantonment, which is published below in full. Special attention is called to the schedule of rental rates. A revision of these rental rates is now under consideration, and in a later issue we shall publish the revised rates.

ARTICLE I.

Extent of the Work.—The Contractor shall, in the shortest possible time, furnish the labor, material, tools, machinery, equipment, facilities, and supplies, and do all things necessary for the construction and completion of the following work:
in accordance with the drawings and specifications to be furnished by the Contracting Officer, and subject in every detail to his supervision, direction and instruction.

The Contracting Officer may, from time to time, by written instructions or drawings issued to the Contractor, make changes in said drawings and specifications, issue additional instructions, require additional work, or direct the omission of work previously ordered, and the provisions of this contract shall apply to all such changes, modifications and additions with the same effect as if they were embodied in the original drawings and specifications. The Contract shall comply with all such written instructions or drawings.

The title to all work completed or in course of construction shall be in the United States; and upon delivery at the site of the work, and upon inspection and acceptance in writing by the Contracting Officer, all machinery, equipment, hand tools, supplies, and materials, for which the Contractor shall be entitled to be reimbursed under paragraph (a) of Article II hereof, shall become the property of the United States. These provisions as to title shall not operate to relieve the Contractor from any duties imposed hereby or by the Contracting Officer.

ARTICLE II.

Cost of the Work.—The Contractor shall be reimbursed in the manner hereinafter described for such of its actual net expenditures in the performance of said work as may be approved or ratified by the Contracting Officer and as are included in the following items:

(a) All labor, material, machinery, hand tools not owned by the workmen, supplies and equipment, necessary for either temporary or permanent use for the benefit of said work; but this shall not be construed to cover machinery or equipment mentioned in section (c) of this Article. The Contractor shall make no departure from the standard rate of wages being paid in the locality where said work is being done, without the prior consent and approval of the Contracting Officer.

(b) All sub-contracts made in accordance with the provisions of this agreement.

(c) Rental actually paid by the Contractor, at rates not to exceed those mentioned in the schedule of rental rates hereto attached, for construction plant in sound and workable condition, such as pumps, derricks, concrete mixers, boilers, clam-shell or other buckets, electric motors, electric drills, electric hammers, electric hoists, steam shovels, locomotive cranes, power saws, engineers' levels and transits, and such other equipment as may be necessary for the proper and economical prosecution of the work.

Rental to the Contractor for such construction plant or parts thereof as it may own and furnish, at the rates mentioned in the schedule of rental rates hereto attached, except as hereinafter set forth. When such construction plant or any part thereof shall arrive at the site of the work, the Contractor shall file with the Contracting Officer a schedule setting forth the fair valuation at that time of each part of such construction plant. Such valuation shall be deemed final, unless the Contracting Officer shall, within five days after the machinery has been set up and is working, modify or change such valuation, in which event the valuation so made by the Contracting Officer shall be deemed final. When and if the total rental paid to the Contractor for any such part shall equal the valuation thereof, no further rental therefor shall be paid to the Contractor and title thereto shall vest in the United States. At the completion of the work, the Constructing Officer may at his option purchase for the United States any part of such construction plant then owned by the Contractor by paying to the Contractor the difference between the valuation of such part or parts and the total rentals theretofore paid therefor.

Rates of rental as substitutes for such scheduled rental rates may be agreed upon in writing between the Contractor and the Contracting Officer, such rates to be in conformity with rates of rental charged in the particular territory in which the work covered by this contract is to be performed. If the Contracting Officer shall furnish or supply any such equipment, the Contractor shall not be allowed any rental therefor and shall receive no fee for the use of such equipment.

(d) Loading and unloading such construction plant, the transportation thereof to and from the place or places where it is to be used in connection with said work subject to the provision hereinafter set forth, the installation and dismantling thereof, and ordinary repairs and replacements during its use in the said work.

(e) Transportation and expenses to and from the work of the necessary field forces for the economical and successful prosecution of the work, procuring labor and expediting the production and transportation of material and equipment.

(f) Salaries of resident engineers, superintendents, timekeepers, foremen, and other employes at the field offices of the Contractor in connection with said work. In case the full time of any field employe of the Contractor is not applied to said work but is divided between said work and other work, his salary shall be included in this item only in proportion to the actual time applied to this work.

(g) Buildings and equipment for necessary field offices, commissary and hospital and the cost of maintaining and operating said offices, commissary and hospital, including such minor expenses as telegrams, telephone service, expressage, postage, etc.

(h) Such bonds, fire, liability and other insurance as the Contracting Officer may approve or require; and such losses and expenses, not compensated by insurance or otherwise, as are found and certified by the Contracting Officer to have been actually sustained (including settlements made with the written consent and approval of the Contracting Officer) by the Contractor in connection with said work, and to have clearly resulted from causes other than the fault or neglect of the Contractor. Such losses and expenses shall not be included in the cost of the work for the purpose of determining the Contractor's fee. The cost of reconstructing and replacing any of the work destroyed or damaged shall be included in the cost of the work for the purpose of reimbursement to the Contractor, but not for the purpose of determining the Contractor's fee, except as hereinafter provided.

(i) Permit fees, deposits, royalties, and other similar items of expense incidental to the execution of this contract, and necessarily incurred. Expenditures under this item must be approved in advance by the Contracting Officer.

(j) Such proportion of the transportation traveling and hotel expenses of officers, engineers and other employes of the Contractor as is actually incurred in connection with this work.

(k) Such other items as should in the opinion of the Contracting Officer be included in the cost of the work. When such an item is allowed by the Contract Officer, it shall be specifically certified as being allowed under this paragraph.

The United States reserves the right to pay directly to common carriers any or all freight charges on material of all kinds, and machinery, furnished under this contract, and certified by the Contracting Officer as being for installation or for consumption in the course of the work hereunder; the Contract shall be reimbursed for such freight charge of this character as it shall pay and as shall be specifically certified by the Contracting officer; but the Contractor shall have no fee based on such expenditures. Freight charges paid by the Contractor for transportation of construction equipment, construction plant, tools and supplies of every character, shall be treated as part of the cost of the work upon which the Contractor's fee shall be based; provided that charges for transportation of such construction equipment, construction plant and tools over distances in excess of five hundred miles shall require the special approval of the Contracting Officer.

No salaries of the Contractor's Executive Officers, no part of the expense incurred in conducting the Contractor's main office, or regularly established branch office, and no overhead expenses of any kind, except as specifically listed above, shall be included in the cost of the work; nor shall any interest on capital employed or on borrowed money be included in the cost of the work.

The Contractor shall take advantage to the extent of its ability of all discounts available, and when unable to take such advantage shall promptly notify the Contracting Officer of its inability and its reasons therefor.

All revenue from the operations of the commissary, hospital or other facilities or from rebates, refunds, etc., shall be accounted for by the Contractor and applied in reduction of the cost of the work.

ARTICLE III.

Determination of Fee.—As full compensation for the services of the Contract, including profit and all general overhead expense, except as herein specifically provided, the Contracting Officer shall pay to the Contractor in the manner hereinafter prescribed a fee to be determined at the time of completion of the work from the following schedule, except as hereinafter otherwise provided:

If the cost of the work is under $100,000.00 a fee of ten per cent (10%) of such cost.

If the cost of the work is over $100,000.00 and under $125,000.00 a fee of $10,000.00.

If the cost of the work is over $125,000.00 and under $250,000.00 a fee of eight per cent (8%) of such cost.

If the cost of the work is over $250,000.00 and under $266,666.67 a fee of $20,000.00.

If the cost of the work is over $266,666.67 and under $500,000.00 a fee of seven and one-half per cent (7½%) of such cost.

If the cost of the work is over $500,000.00 and under $535,714.29 a fee of $37,500.00.

If the cost of the work is over $535,714.29 and under $3,000,000.00 a fee of seven per cent (7%) of such cost.

If the cost of the work is over $3,000,000.00 and under $3,500,000.00 a fee of $210,000.00.

If the cost of the work is over $3,500,000.00 a fee of six per cent (6%) of such cost.

Provided, however, that the fee upon such part of the cost of the work as is represented by payments to sub-contractors, under subdivision (b) above, shall in each of the above contingencies be five per cent (5%) and no more of the amount of such part of the cost.

The cost of materials purchased or furnished by the Contracting Officer for said work, exclusive of all freight charges thereon, shall be included in the cost of the work for the purpose of reckoning such fee to the Contractor, but for no other purpose.

The fee for reconstructing and replacing any of the work destroyed or damaged shall be such percentage of the cost thereof—not exceeding seven per cent (7%)—as the Contracting Officer may determine.

The total fee to the Contractor hereunder shall in no event exceed the sum of $250,000.00, anything in this agreement to the contrary notwithstanding.

ARTICLE IV.

Payments.—On or about the seventh day of each month the Contracting Officer and the Contractor shall prepare a statement showing as completely as possible: (1) the cost of the work up to and including the last day of the previous month, (2) the cost of the materials furnished by the Contracting Officer up to and including such last day, and (3) an amount equal to three and one-half per cent (3½%), except as herein otherwise provided, of the sum of (1) and (2) on account of the Contractor's fee; and the Contractor at such time shall deliver to the Contracting Officer original signed pay-rolls for labor, original invoices for materials purchased and all other original papers not theretofore delivered supporting expenditures claimed by the Contractor to be included in the cost of the work. If there be any item or items entering into such statement upon which the Contractor and the Contracting Officer cannot agreet, the decision of the Contracting Officer as to such disputed item or items shall govern. The Contracting Officer shall then pay to the Contractor on or about the ninth day of each month the cost of the work mentioned in (1) and the fee mentioned in (3) of such statemen, less all previous payments. When the statement above mentioned includes any work of reconstructing and replacing work destroyed or damaged, the payment on account of the fee in (3) for such reconstruction and replacement work shall be computed at such rate, not exceeding three and one-half per cent (3½%), as the Contracting Officer may determine. The statement so made and all payments made thereon shall be final and binding upon both parties hereto, except as provided in Article XIV hereof. The Contracting Officer may also make payments at more frequent intervals for the purpose of enabling the Contractor to take advantage of discounts at intervals between the dates above mentioned or for other lawful purposes. Upon final completion of said work the Contracting Officer shall pay to the Contractor the unpaid balance of the cost of the work and of the fee as determined under Articles II and III hereof.

ARTICLE V.

Inspection and Audit.—The Contracting Officer shall at all times be afforded proper facilities for inspection of the work and shall at all times have access to the premises, to the work and material, and to all books, records, correspondence, instructions, plans, drawings, receipts, vouchers, and memoranda of every description of the Contractor pertaining to said work; and the Contractor shall preserve for a period of two years after its completion of cessation of work under this contract, all the books, records and other papers just mentioned. Any duly authorized representative of the Contractor shall be accorded the privilege of examining the books, records, and papers of the Contracting Officer relating to said work for the purpose of checking up and verifying the cost of said work. The system of accounting to be employed by the Contractor shall be such as is satisfactory to the Contracting Officer.

If at any time the Contracting Officer shall find that bills for labor, material, or other bills legitimately incurred by the Contractor hereunder, are not promptly paid by the Contractor, the Contracting Officer may, in his discretion, refuse to make further payments to the Contractor until all such obligations past due shall have been paid. Should the Contractor neglect or refuse to pay such bills within five days after notice from the Contracting Officer so to do, then the Contracting Officer shall have the right to pay such bills directly, in which event such direct payments shall not be included in the cost of the work.

ARTICLE VI.

Special Requirements.—The Contractor hereby agrees that it will:

(a) Begin the work herein specified at the earliest time practicable, and diligently proceed so that such work may be completed at the earliest possible date.

(b) Promptly pay for all labor, material or other service rendered.

(c) Procure, and thereafter maintain such insurance, in such forms and in such amounts, and for such periods of time as the Contracting Officer may approve or require.

(d) Procure all necessary permits and licenses, and obey and abide by all laws, regulations, ordinances, and other rules applying to such work, of the United States of America, of the State or Territory wherein such work is done, of any subdivision thereof, or of any duly constituted public authority.

(e) Unless this provision is waived by the Contracting Officer, insert in every contract made by it for the furnishing to it of services, materials, supplies, machinery and equipment, or the use thereof, for the purposes of the work hereunder, a provision that such contract is assignable to the United States; will make all such contracts in its own name, and will not bind or purport to bind the United States or the Contracting Officer thereunder.

(f) In every sub-contract made in accordance with the provisions hereof, require the sub-contractor to agree to comply fully with all the undertakings and obligations of the Contractor herein, excepting such as do not apply to such sub-contractor's work

(g) At all times keep at the site of the work a duly appointed representative who shall receive and execute on the part of the Contractor such notices, directions and instructions as the Contracting Officer may desire to give.

(h) At all times use its best efforts in all its acts hereunder to protect and subserve the interest of the Contracting Officer and the United States.

ARTICLE VII.

Right to Terminate Contract.—Should the Contractor at any time refuse, neglect, or fail in any respect to prosecute the work with promptness and diligence or default in the performance of any of the agreements herein contained, the Contracting Officer may, at his option, after five days written notice to the Contractor, terminate this contract, and may enter upon the premises and take possession, for the purpose of completing said work, of all materials, tools, equipment, and appliances, and all options, privileges and rights, and may complete, or employ any other person or persons to complete said work. In case of such termination of the contract, the Contracting Officer shall pay to the Contractor such amounts of money on account of the unpaid balance of the cost of the work and of the fee as will result in fully reimbursing the Contractor for the cost of the work up to the time of such termination, plus a fee computed thereon at the rate or rates for monthly payments set forth in Article IV hereof; and the Contracting Officer shall also pay to the Contractor compensation, either by purchase or rental at the election of the contracting Officer, for any equipment retained; such compensation, in the event of rental, to be in accordance with paragraph (c) of Article II, and in the event of purchase to be based upon the valuation determined by the Contracting Officer as of the time of his taking such possession. The Contractor hereby agrees that such payments when made shall constitute full settlement of all claims of the Contract against the Contracting Officer and the United States or either of them for money claimed to be due to the Contractor for any reason whatsoever. In case such termination of the contract the Contracting Officer shall further assume and become liable for all such obligations, commitments, and unliquidated claims as the Contractor may have theretofore in good faith undertaken or incurred in connection with said work, and the Contractor shall, as a condition of receiving the payments mentioned in this Article, execute and deliver all such papers, and take all such steps as the Contracting Officer may require for the purpose of fully vesting in him the rights and benefits of the Contractor under such obligations or commitments. When the Contracting Officer shall have performed the duties incumbent upon him under the provisions of this Article, the Contracting Officer shall thereafter be entirely released and discharged of and from any and all demands, actions, or claims of any kind, on the part of the Contractor hereunder or on account hereof.

ARTICLE VIII.

Abandonment of Work by Contracting Officer.—If conditions should arise which in the opinion of the Contracting Officer make it advisable or necessary to cease work under this contract, the Contracting Officer may abandon the work and terminate this contract. In such case the Contracting Officer shall assume and become liable for all such obligations, commitments and unliquidated claims as the Contractor may have theretofore, in good faith, undertaken or incurred in connection with said work; and the Contractor shall, as a condition of receiving the payments mentioned in this Article, execute and deliver all such papers, and take all such steps as the Contracting Officer may require for the purpose of fully vesting in him the rights and benefits of the Contractor under such obligations or commitments. The Contracting Officer shall pay to the Contractor such an amount of money on account of the unpaid balance of the cost of the work and of the fee, as will result in the Contractor receiving full reimbursement for the cost of the work up to the time of such abandonment, plus a fee to be computed in the following manner: To the cost of the work up to the time of such abandonment shall be added the amount of the contractual obligations or commitments assumed by the Contracting Officer, and such total shall be treated as the cost of the work, upon which the fee shall be computed in accordance with the provisions of Article III hereof. When the Contracting Officer shall have performed the duties incumbent upon him under the provisions of this Article, the Contracting Officer and the United States shall thereafter be entirely released and discharged of and from any and all demands, actions or claims of any kind on the part of the Contractor hereunder or on account hereof.

ARTICLE IX.

Bond.—The Contractor shall prior to commencing the said work furnish a bond, with sureties satisfactory to the Contracting Officer, in the sum of Two Hundred Fifty Thousand Dollars ($250,000.00), conditions upon its full and faithful performance of all the terms, conditions and provisions of this contract, and upon its prompt payment of all bills for labor, material, or other service furnished to the Contractor.

ARTICLE X.

Convict Labor.—No person or persons shall be employed in the performance of this contract who are undergoing sentence of imprisonment at hard labor imposed by the courts of any of the several states, territories, or municipalities having criminal jurisdiction.

ARTICLE XI.

Hours and Conditions of Labor.—No laborer or mechanic doing any part of the work contemplated by this contract, in the employ of the Contractor, or any sub-contractor contracting for any part of said work contemplated, shall be required or permitted to work more than eight (8) hours in any one calendar day upon such work, such prohibition being in accordance with the Act approved June 19, 1912, limiting the hours of daily service of mechanics and laborers on work under contracts to which the United States is a party. For each violation of the requirements of this Article a penalty of Five Dollars ($5.00) shall be imposed upon the Contractor for each laborer or mechanic for every calendar day in which said employe is required or permitted to labor more than eight (8) hours upon said work, and all penalties thus imposed shall be withheld for the use and benefit of the United States; Provided, that this paragraph shall not be enforced nor shall any penalty be exacted in case such violation shall occur while there is in effect any valid Executive order suspending the provisions of said Act approved June 19, 1912, or waving the provisions and stipulations thereof with respect to either this contract or any class of contracts in which this contract shall be included, or when the violation shall be due to any extraordinary events or conditions of manufacture, or to any emergency caused by fire, famine, or flood, by danger to life or property, or by other extraordinary events or conditions on account of which, by susbsequent Executive order, such past violation shall have been excused.

In the event of any dispute with reference to wages, hours, or other conditions appertaining to said work, between the Contractor or any sub-contractor and labor employed by him on said work, the Contractor or sub-contractor shall immediately notify the Contracting Officer of the existence of such dispute and the reasons therefor. The Contracting Officer may, at his option, instruct the Contractor or sub-contractor involved in such dispute as to the method or steps which the Contractor or subcontractor should follow with reference thereto, and the Contractor or sub-contractor shall thereupon comply with such instructions.

ARTICLE XII.

Right to Transfer or Sublet.—Neither this contract, nor any interest therein, shall be assigned or transferred. The Contractor shall not enter into any sub-contract for any part of the work herein specified without the consent and approval in writing of the Contracting Officer. In case of such assignment, transfer, or sub-letting without the consent and approval, in writing, of the Contracting Officer, the Contracting Officer may refuse to carry out this contract either with the transferror or transferee, but all rights of action for any breach of this contract by the Contractor are reserved to the United States.

ARTICLE XIII.

No Participation in Profits by Government Officials.—No member of, or delegate tc, Congress, or Resident Commissioners, nor any other person belonging to or employed in the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom, but this Article shall not apply to this contract so far as it may be within the operation or exception of Section 116 of the Act of Congress approved March 4, 1909 (35 Stats., 1109).

ARTICLE XIV.

Settlement of Disputes.—This contract shall be interpreted as a whole and the intent of the whole instrument, rather than the interpretation of any special clause, shall govern. If any doubts or disputes shall arise as to the meaning or interpretation of anything in this contract, or if the Contractor shall consider himself prejudiced by any decision of the Contracting Officer made under the provisions of Article IV hereof, the matter shall be referred to the Officer in charge of Cantonment Construction for determination. If, however, the Contractor shall feel aggrieved by the decision of the Officer in charge of Cantonment Construction, he shall have the right to submit the same to the Secretary of War, whose decision shall be final and binding upon both parties hereto.

ARTICLE XV.

This contract shall bind and insure to the Contractor and its successors.

It is understood and agreed that wherever the words "Contracting Officer" are used herein, the same shall be construed to include his successor in office, any other person to whom the duties of the Contracting Officer may be assigned by the Secretary of War and any duly appointed representative of the Contracting Officer.

SCHEDULE OF RENTAL RATES.

(The rates mentioned are per day.)

Automobiles	$5.00
Adding and listing machines	.20
Buckets, tipple and bottom dump	.25
Boring machine, pneumatic	.50
Boring machine, electric	.50
Buckets, orangepeel, 1 yard	3.50
Buckets, orangepeel, less than 1 yard	2.00
Buckets, clamshell	2.00
Boiler, and 3 drum engine	3.50
Boiler, and 2 drum engine	3.00
Boiler, and 1 drum engine	2.50
Boiler, only 30 hp. and smaller	1.50
Boiler only, larger than 30 hp	2.00
Block machine, concrete	1.50
Cars, skip, 1½ yards	.25
Cars, skip, 3 yards	.50
Cars, steel, 1 yd. and smaller	.15
Cars, 4 yd. wooden	.25
Cars, 6 yd. wooden	.75
Cars, 12 yd. wooden	2.00
Cars, 1 hopper, radial gate	.25
Crushers only	2.00
Crushers, with elevator and screen	3.00
Conveyor, gravity, per 100 feet	1.00
Compressor, 10x10 with Steam Engine	2.50
Compressor, 8x8 Belt Driven	1.00
Compressor, with Gasoline Engine on Wheels	5.00
Compressor, Westinghouse, 9½ inch	1.00
Cableways, without Engine	4.00
Drill, Auto Traction	5.00
Dump Wagons	.25
Diving outfit with pumps	10.00
Derricks, 60 ft. to 85 ft	2.00
Derricks, 30 ft. to 59 ft	1.50
Derricks, less than 30 ft	1.00
Derricks, breast	.25
Derricks, circle swing	.25
Elevators, platform or bucket	.25
Elevators, with bins for concrete	.50
Engines, skeleton, 3 drum	2.00
Engines, skeleton, 2 drum	1.50
Engines, skeleton, 1 drum	1.00
Engines, steam, horizontal, 11 to 40 hp	1.50
Engines, steam, upright, to 10 hp	.50
Engines, gasoline, to 8 hp	.50
Engines, 2 drum, with electric motor	4.00
Engines, gasoline, 10 hp	1.00
Engines, derrick, swinging	.50
Hammers, rivetting	.25
Hod elevating machine	1.00
Levelling instruments, engineers'	.25
Locomotive, 36 inch gage	5.00
Locomotive, standard gage	10.00
Mixers, with boiler sideloader	4.00
Mixers, with electric motors, 1 yard	4.00
Mixers without boiler, less than 1 yard	2.00
Mixers without boiler, 1 yard and larger	3.50
Mixers with gasoline engine	3.00
Motorcycles	1.00
Motors, 2 hp	.15
Motors, 5 hp	.25
Motors, 10 hp	.50
Motors, 25 hp	1.00
Motors, 50 hp	2.00
Pumps, centrifugal, 10 inch, belt driven	3.00
Pumps, centrifugal, 10 inch with motor attached	4.00
Pumps, centrifugal, 8 inch steam connected	2.00
Pumps, centrifugal, 6 inch, steam connected	1.50
Pumps, centrifugal, 4 inch, steam connected	1.00
Pumps, duplex and triplex to 3 inch	.50
Pumps, pulsometer to 4 inch	1.55
Pumps, diaphragm	.20
Pumps, diaphragm, with gas engine	1.05
Pumps, triplex, with belt drive	.20
Pile drivers, drop	1.50
Pile drivers, drop, with single drum engine and boiler	3.50
Pile hammers, steam, up to 2,500 lbs	3.00
Pile hammers, steam, larger than 2,500 lbs	5.00
Rail, per ton	.06
Roller, horse	1.00
Steam drills	1.00
Small air drills	.50
Steam roller	8.00
Steam shovel	30.00
Sprinkling cart	1.00
Saw benches	.25
Saw benches, with motor or gasoline engine	.50
Scale boxes	.25
Scraper, wheel	.50
Transits	.50
Typewriter	.10

Fuel and lubricants not included in these prices.

Relations of the Engineer and Contractor*

Relationships and duties of the engineer and contractor are mutual and supplementary; they are the links that bind them in the chain of events, on their common task. The engineer and contractor are both technical men; one designs the work, the other manages its construction; the engineer plans, and works out the details of the structures, while the contractor prepares the methods of erection and the means of completion; therefore, the superiority of the engineer is passing away in proportion to the training, experience and adaptability of the contractor to his task.

If the engineer, during the different stages of his planning, designing and detailing and proposed work, will carefully and conscientiously consider the fundamental interests of the contractor and the probable difficulties he may encounter in manufacturing, assembling, transporting and erecting the different parts of the structure, he will not only render honorable duty to the contractor, but also materially benefit his client and give real service to the community. There is no doubt that the modern and capable engineer always has these obligations before him as a guide for greater tasks, and an aid for wider reputation.

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*From a paper presented by Andrew Nicola, contracting engineer, before the Brooklyn Engineers' Club.

The duties of the contractor to the engineer are few and fundamental; he should not crowd the engineer out of his position on the work, neither should he attempt to eliminate him as consulting and supervising agent. There are great duties and enough honor for all, and no one should be overjealous of the other's position, prosperity or reputation; but each should strive nobly to make this world better and happier home for mankind by doing his level best on the spot he occupies, whether he is spacing rivets, managing office or field work, or in the factory or in the front trenches.

Most of the fundamental and frequent causes of the disputes that arises between the engineer and contractor may be classified as follows:

Love of superiority on the part of the engineer and his constant tendency to maintain a higher position of command over the contractor; and the exercise of a free hand in changing the ways, means and quantity of construction. His natural excuse is professional, hereditary tendency, and the common pretence is the interest of the client.

On the other hand, the contractor, personally, resents the engineer's motives, and consequently often persists, under the law of self-preservation, to adopt expediency instead of the technical ways and means outlined by the engineer for performing the work.

The abnormal desire of the contractor to get rich quick, sometimes plunges him into the adoption of methods which cannot be approved by the reputable engineer, and which so often proved to be the downfall of many a promising citizen and the degradation of few good engineers, who acquiesced to such unlawful variation from the approved and adopted standards.

The influence of the lawyer and the place he occupies in the contract is a bad link in the chain of mutual dealings between the engineer and contractor. In my opinion the contract should be drawn by the engineer and approved by the contractor, to fit the particular conditions, time and place of the work, in the same way as the specifications are prepared and executed; and, by no means, should such blind clauses and undefined general terms be used or allowed to remain, as are now inserted in the lawyer-made-contracts.

The trial of important engineering and contracting cases by judges of narrow experience, lawyers of limited knowledge and a jury consisting of ignorant men supposed to be endowed with normal and impartial minds, is a grave mistake and a cause for greater and future disputes. In my opinion, a case between engineer and contractor, should be tried by a jury consisting of six engineers and six contractors. When the rights of a client are involved in the case, the jury box should contain four engineers, four contractors and four citizens of other professions; and the decision of the majority should be final.

Personals

E. L. Gostin has been appointed city engineer of Macon, Ga.

Lewis B. Sebring has been appointed city engineer of Schenectady, N. Y.

Warren R. Neel has been appointed chief engineer of the State Highway Department of Georgia.

George S. [illegible] has been appointed County Highway Engineer of Kalamazoo County, Michigan.

L. M. Russell, City Engineer of Elkhart, Ind., has resigned this position to become associated with Arthur J. Sweet, Consulting Engineer of Milwaukee, Wis.

R. J. Windrow of Waco, Tex., recently appointed a member of the State Board of Water Engineers of Texas, to succeed J. C. Nagle, resigned, has taken office.

C. M. Osborn, for the past ten years city engineer of Lorain, O., has been appointed city manager of East Cleveland, a suburb of Cleveland, O., and will take office on Jan. 1.

Frank R. Stone, a road contractor of Lima, O., has received a commission as first lieutenant in the Twenty-third Engineering Corps and has reported for duty at Camp Mead, Maryland.

C. Beverley Broun, Ivory C. Jordan, Graham C. Painter, Connor Hall and John H. Taylor, all of Charleston, W. Va., have organized the Dunbar Construction Co., of Dunbar, W. Va.

Chalmers Miller, for the past two years assistant city engineer of Lorain, O., has been appointed city engineer to succeed C. M. Osborne, who resigned to become city manager of East Cleveland.

William J. Hardaker of Reading, Pa., has been appointed general superintendent of the Reading Transit & Light Co. and the Metropolitan-Edison Electric Co. interests in Lebanon County, Pennsylvania.

James C. Pinney, Jr., President Milwaukee Chapter of the American Association of Engineers, formerly Superintendent of Bridges and Public Building for the City of Milwaukee, has recently been offered the position of Dean of the College of Engineernig of Marquette University.

Captain R. R. Jones, Cincinnati, O., Chief Assistant Engineer of Cincinnati District No. 1, Corps of Engineers, has been installed as officer in charge of the district, relieving Colonel Lansing H. Beach, United States Division Engineer, who has been in charge since the transfer of Major R. R. Ralston to training camp duty at Ft. Oglethorpe, Ga.

The Japanese Imperial Railway Commission now in this country for the purpose of inspecting American railways and purchasing supplies includes Dr. Yasujiro Shima, director of machinery and rolling stock departments of the Japanese Imperial Government Railways; Jiro Nakamura, chief engineer; Aiko Kasama, traffic manager, and D. Kobayashi, resident inspector.

George H. Brown, heretofore division engineer of the Philadelphia division of the Pennsylvania R. R., has been promoted to the office of principal assistant engineer of the Eastern Grand division with offices at Altoona, succeeding A. B. Cuthbert, who was made engineer of the Cresson division. Elmer Irving, division engineer at Trenton, succeeds Mr. Brown as division engineer on the Philadelphia division. Mr. Brown formerly was engineer of the Middle division. Mr. Irving was formerly supervising engineer at Lancaster before being transferred to Trenton.

Obituaries

P. W. Ryan, a railroad contractor, died last week at his home in Janesville, Wis. He built the first railroad into Monroe, Wis., over 30 years ago. He also built the line from Palatine to Wauconda, Ill., and the Mineral Point division.

James F McNichol, a well-known contractor, of Philadelphia, Pa., died Nov. 14 at the home of his son in Philadelphia, where he had been ill for several weeks following an attack of acute indigestion. Death was due to dilatation of the heart. He was [illegible] years old.

Industrial Notes

The Boston Belting Co., Boston, Mass., has recently made a shipment of belting for conveying and elevating ore in the new mills at Bowdin Mines in Burmah. The orders weighed 22 tons and will travel about 18,000 miles to reach its destination.

The Sullivan Machinery Co. announces that Joseph H. Brown, hitherto Assistant Manager of its New York City office, has been appointed District Sales Manager at Chicago, to succeed William P. J. Dinsmoor, who has resigned to engage in business at Denver, Colo.

Wallace T. Roberts, hitherto sales engineer for the Sullivan Machinery Co. in lower Michigan, Northern Ohio and Northern Indiana, has been appointed District Manager at Denver. Mr. Roberts succeeds Captain Matt. R. Blish, Ordnance Department, U. S. A., Acting Manager at Denver since last May. Geo. W. Blackinton, Manager at Denver up to May last, is Captain, commanding Third Battalion, Three Hundred and Fifty-thir Infantry Regiment, National Army, Camp Funston, Kan.

The Terwilliger Equipment Co. has recently incorporated its rapidly increasing business and removed from 314 Bulletin Bldg., Philadelphia, to its new quarters, 2013 Market St. The personnel of this firm is as follows: President, E. M. Terwilliger, formerly in charge of the Philadelphia office of the Austin-Western Road Machinery Co.; Vice-President, H. E. Green, for the past 7 years district manager of the Browning Co.; Secretary, John A. Conboy, who had charge of the concrete mixer department of the Standard Supply & Equipment Co.; Treasurer, W. George Brooks, until recently sales-manager of the Packard Motor Car Co.

At the annual meeting of the National Paving Brick Manufacturers' Ass'n held in Cleveland, Ohio, on Nov. 19 and 20, the following officers were elected for the ensuing year: C. C. Blair, President; J. L. Murphy, Vice President; Will P. Blair, Secretary; C. C. Barr, Treasurer. J. W. Robb, who has served as Vice-President, declined re-election to that office and J. L. Murphy was elected instead. H. H. Macdonald, who has served as Assistant Secretary for several years, declined re-election and tendered his resignation and will become Secretary of the Gypsum Industries Association with headquarters at Chicago, Ill. Resolutions of appreciation of Mr. Macdonald's service were passed by the Association.

The following conventions will be held during the week of the Contractors' and Builders' Show at Chicago, Feb. 6 to 13, 1918: American Association of Engineers, American Concrete Institute, American Concrete Pipe Association, Central Association of Lumber Sash and Door Salesmen, Illinois Lumber and Builders' Supply Dealers' Association, National Association of Sand and Gravel Producers, National Builders' Supply Association. The Contractors' and Builders' Show will be an open forum for the display of machinery, equipment and building materials of all kinds for the construction of offices, factories, warehouses, power plants, etc.; for homes of cement, lumber, brick and tile; for roads of concrete, brick, asphalt and block.

Road and Street
Monthly Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power

Excavation and Govt. Works—3rd Wednesday
- (a) Excavation and Dredging
- (b) Rivers and Canals
- (c) Harbors and Docks
- (d) Railway Construction

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Ship Construction
- (d) Miscellaneous Structures

Volume XLVIII. CHICAGO, ILL., DECEMBER 5, 1917. Number 23.

10,000 American Road Building Engineers Will Do as Much as 40,000 British Troops in France

In an address before the American Road Builders' Association, Nov. 2, Maj. I. C. Moller, of the 23d Engineers, said that it had been estimated that the 10,000 men of the 23d Engineers—the Road Building Regiment—will accomplish as much as 40,000 British troops have been able to accomplish on the highway work in France. This four to one ratio does not, of course, represent the relative efficiency of the individual men of the two countries; but it will exist because the British have had comparatively little road building equipment, whereas the Americans will be fully equipped with the best of American machinery for grading, hauling, surfacing, etc. It is expected that the American engineers will maintain about 2,000 miles of roads in France, in addition to building new routes.

The New Highways Committee of the Council of National Defense

The Council of National Defense has appointed a Highways Transport Committee whose main function will be to co-ordinate railway and highway transportation. The members of the committee are: Roy D. Chapin, of Detroit, chairman; Logan Waller Page, head of the Office of Public Roads; Henry G. Shirley, chief engineer of the Maryland Road Commission; and George H. Pride, New York. Mr. Chapin is secretary of the National Automobile Chamber of Commerce, also vice president of the Lincoln Highway Association. It is announced that the Council of National Defense plans to encourage the use of motor trucks for short distance freight haulage, especially of farm produce. We suggest that the Council, through its new Highways Transport Committee, should take immediate steps to show city and county officials the importance of increasing rather than decreasing the annual expenditures for roads and streets.

"The Advice of a Paving Expert Would Have Saved the City $6,000"

A letter from one of our subscribers, relative to the editorial in our Nov. 7 issue entitled "Why Are There So Few Consulting Highway Engineers?", urges us to continue pointing out the benefits to be derived from the advice of competent consulting engineers. Our correspondent says: "I was looking over a newly paved street yesterday where the advice of a competent expert would surely have saved the city at least $6,000."

Speaking of the reason why expert highway engineers are seldom called in consultation by city and county engineers, our correspondent says:

> The fault is not so much with city engineers as with city councils and road officials, who simply do not realize or appreciate the importance and value of expert knowledge and advice in this field of municipal work. The average city councilman knows far more about pavements and roads than any expert in this country. Only a few days ago a member of the council in a city of over 40,000 population undertook to enlighten me on the subject of the relative value and the proper methods of constructing pavements. He is an unusually intelligent man, a college graduate, a lawyer of some note—and for years a friend of mine. The young city engineer in that city some time ago asked to have me retained to advise him in pavement work, but the council—on the whole much above the average in character and intelligence—scoffed at the idea on the ground that it was wholly unnecessary and that the fee paid would be an inexcusable waste of the city money.
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> I have watched these things pretty carefully, over a pretty large field, and I think you will agree with me in saying that if such an arrangement were practicable a competent paving expert would want no more lucrative practice than to act as consulting engineer for almost any city of 10,000 or more population on condition that his compensation should be 10 per cent of what he could save in the construction and maintenance of its pavements.
>
> I think that the press, technical and otherwise, could do no service to the municipal public more important and economically valuable than persistently to call attention to the fact that the

design, construction and maintenance of streets and highways is a field where sound expert advice and direction is just as necessary and important as in the case of sewers, water supply, etc. In fact, because of the relative greater financial magnitude of this work in most cities, it is often very much more important from the economical point of view. The very prevalent idea that pavements and roads are simple matters with which any city official is fully competent to deal must be dispelled before any reform can be brought about.

When Did Roads and Streets Become "Not Essential to the National Defense and Security?"

At the close of the astonishing "Priority Order No. 2," signed by Robert S. Lovett, chairman of the War Industries Board, under which gondola cars are not to be supplied for hauling road and street materials, we find these words: "which articles the undersigned finds are not essential to the national defense and security."

This declaration is so astounding as to be scarcely credible, particularly since it is made by a man who is chairman of the executive committee of the Union Pacfic Ry. Although railway officials have frequently shown inadequate appreciation of the economic importance of roads, never before has there been published even an intimation that any railway official regarded roads as "not essential to national defense and security."

The world war has demonstrated that without her wonderful system of highways, France would have been crushed long ago. But we do not have so prominently in mind the military necessity of roads in America as their industrial necessity in times of war. At the very moment when American farmers are faced with a shortage of labor, when transportation of farm products will be curtailed by the labor shortage unless better roads are provided, there comes "Priority Order No. 2."

Judge Lovett has issued a statement to the effect that the order is an emergency measure and "will not be continued in force a day longer than absolutely necessary." This is encouraging news, but a more definite statement is needed, one in which it will be made clear that this high official does not regard road materials as being "non-essential to national defense and security."

A Motor Truck Representative Urged for the Highways Transport Committee

At a recent meeting of the Ohio Good Roads Federation resolutions were passed urging the appointment of a representative of the motor truck industry as a member of the Highways Transport Committee. It seems to us that the committee would be strengthened materially by such an addition.

Men engaged in the manufacture and marketing of motor trucks are probably the best informed as to the economics of motor trucking. They know, for example, to what an extent economic motor truck haulage is dependent on the existence of good roads and streets. Their experience in the maintenance of trucks has taught them how essential it is to eliminate rough pavements in the city and mud in the country. The nation needs the benefit of that experience, and it needs it now.

The Highways Transport Committee may well devote a large part of its time to a study of the entire problem of the co-ordination of road transportation with railway transportation. As it now stands, railways are built and operated by men who know very little about roads and streets, and highways are designed and supervised by those who know little about railway economics. Yet roads and railways, so far as the public is concerned, are merely parts of one vast transportation plant. Certainly some one should study the relation of the parts of this plant to one another. Hitherto no one ever has entered upon such a study.

"Encourage the Use of Motor Trucks for Short Haul Freight"

The Railroads' War Board on Nov. 15 issued a bulletin to all the railways giving many valuable suggestions on the steps to be taken to increase railway efficiency. Hint No. 11 reads: "Encourage the use of motor trucks and co-operation with trolley lines for handling short-haul freight." This admirable bit of advice, however, is scarcely concordant with "Priority Order No. 2," which forbids the use of gondola cars for hauling road and street materials on the ground that such materials are "not essential to the national defense and security." Here we have two opposed theories, one expressing belief in the assistance that motor trucks can render the railways, and the other tacitly denying that motor trucks can be of assistance; for to declare that road materials are non-essentials is tantamount to asserting that motor trucks also are non-essential!

Is Coal for Gewgaw Factories More "Essential" Than Broken Stone for Roads?

"Since this war is as much a war of food and other resources as it is of manpower and ammunition, it is my conception of the road situation in America that every road in the land is a military road." This striking expression is uttered in a letter to us by J. E. Kaulfuss, Highway Engineer, North Dakota Highway Commissioner, in protest against "Priority Order No. 2," which withdraws gondola cars from use in transporting road and street materials, so that such cars can be used for coal haulage.

World transportation is not confined to car and ship. It does not originate in one railway station or wharf and end at another one. It begins at the farm or mine or other place where the earth yields initially to man's efforts, and between this point of origin and the railway station lies the road over which the produce must be hauled. The cost of this road haulage can be greatly reduced only by so greatly improving the highways that motor trucks can haul large loads at all seasons of the year. If ever in our American history there was a time when reduced hauling costs were more imperative than now, we should like to know when. Yet according to "Priority Order No. 2" materials for roads are classed as non-essentials!

Are jimcracks and gewgaws essential? If not, the coal that is hauled to the thousands of factories of women's finery is, for the most part, traveling on a non-essential mission. If there is to be wholesale restriction in the use of open top cars, let it not be on the ground that coal is more essential for gewgaw factories than broken stone for country roads.

The Dissolution of the American Highway Association Offers an Opportunity to the American Road Builders' Association

The American Highway Association, having accomplished the purpose for which it was organized seven years ago, has dissolved. A brief history of the association appeared in our Road and Street issue of Nov. 7, together with a full statement of the reasons why its board of directors decided to bring the life of the association to a close.

The passing of the American Highway Association leaves the American Road Builders' Association as the only national organization of its kind. We had frequently urged a consolidation of these two societies, for, although their aims were not precisely parallel, there was a considerable duplication of effort.

The American Road Builders' Association now has an opportunity to attach to itself many of the former members of the American Highway Association and to become a very large national society. But to do so it must first show itself to be an independent organization. Its present membership of 1,000 can readily be doubled under the direction of a competent secretary who will devote his entire time to the association, and who has no personal ax to grind.

Public Bodies Protest Against the Embargo on Gondola Cars for Road Materials

Several associations have already protested against "Priority Order No. 2," and many more will doubtless follow their lead. The U. S. Chamber of Commerce recently passed this resolution:

> Whereas, It is essential that all the transportation facilities of the nation should be brought to the highest state of efficiency in order that foodstuffs may be moved most economically from the farm to the market, that manufactured products be moved at the lowest cost from the factory to the consumer, and
>
> Whereas, The public highways offer a good, prompt and economical means to supplement transportation by rail and water; therefore be it
>
> Resolved, That the prompt improvement of our public highways is important and should be forwarded in every proper way.

Elsewhere we print in full the resolutions adopted by the Ohio Good Roads Federation.

How to Reduce Hand Trimming of Subgrades

Small steam shovels are being used more and more for grading streets and roads. With the growing scarcity and high price of labor, machines will be used more extensively than ever, even for grading very shallow cuts. But in order to make machine work highly economic on shallow cuts it is necessary to eliminate practically all hand trimming of subgrades. Road machines and leveling scrapers, if properly handled, can be used to trim subgrades in most soils; but frequently the soil is so tough or so stoney that trimming can not be done cheaply in this manner. In such cases it often pays to excavate all the earth with the steam shovel to a depth a few inches below subgrade. Then cast or dump loose earth back onto the subgrade and roll it down to the desired level, after smoothing it with a leveling scraper. It may even pay to harrow and sprinkle the earth in order to break up hard clods that interfere with the leveling. The method of excavating below grade is also frequently advantageous where trenches are dug for curbs and the like, the spoil then being shoveled directly onto the subgrade without the necessity of hauling it away.

Why Ditches Often Provide Inadequate Drainage

H. E. Bilger, Road Engineer, Illinois State Highway Department, states that probably for more than half the roads in Illinois the travelled surface is lower than the adjacent ground level. This condition is particularly objectionable in clayey soil where the land is nearly level, for the side ditches seldom have sufficient slope to drain the subgrade properly. A subgrade should be above the level of the adjacent fields in such cases; and Mr. Bilger lays down this rule: In clay soil where the obtainable side-ditch grade is less than 0.4%, a stretch of not more than 800 ft. of subgrade should exist with its crown less than 12 in. above the ground level, regardless of the size of the ditches.

We favor broadening this rule by eliminating any reference to the side ditches, for the accumulation of snow and slush in side ditches often renders them practically useless even where their gradient exceeds 0.4 per cent.

Monolithic Brick Slabs as Strong as Concrete Slabs

If a concrete pavement 6 in. thick is strong enough to carry a given wheel load, what thickness of monolithic brick pavement is necessary to carry the same load?

If transverse strength tests on 66 slabs made under the direction of C. C. Wiley, instructor in highway engineering at the University of Illinois, are sufficient evidence, the answer to the above question is 6 in. In other words, a composite slab made of paving brick laid direct on concrete is as strong as an all concrete slab of equal thickness.

The tests showed that for 1:2:3 concrete slabs 6 to 7 in. thick and 23x45 in., 28 days old, the modulus of rupture was about 480 lb. per square inch. Monolithic slabs made of a course of 4 in. of brick, bedded in 1:3:5 concrete 3 in. thick, and grouted with 1:1 grout, showed almost the same modulus of rupture, 480 lb. at the end of 28 days.

Mr. Wiley concludes that a monolithic brick slab 7 in. thick should not be regarded as a 4-in. wearing coat of brick upheld by a 3-in. concrete base, but it should be regarded as having as much strength as a concrete slab 7 in. thick.

Compacting Concrete in Walls by Jarring the Forms

Reinforced concrete for building walls is commonly mixed quite wet and is usually compacted, by spading it. Concrete containing less water, and of a quaky rather than fluid consistency, is sometimes specified; but it can not be economically tamped in thin reinforced walls. However, it can be compacted by striking the forms and the reinforcing bars with a light wooden maul. This suggests the possibility of using a pneumatic hammer for this purpose, for a large number of sharp, light raps should prove effective in causing the concrete to settle tightly in the forms.

Should a Concrete Road Be Thicker at the Center Than at the Sides?

About 16 years ago the editor wrote a little book on road construction in which he advocated a pavement thicker at the center than at the sides. But he then had reference to macadam which was practically the only type of country road pavement in extensive use. Macadam roads, when worn, are resurfaced by adding more broken stone. Since most of the wear is in the center of the road, a greater center thickness is desirable to provide for the prospective wear. With concrete roads no such reason holds. Now that heavily loaded motor trucks are in common use, it may well be questioned whether even a macadam road should be made thicker at the center than at the sides; certainly concrete should be of uniform thickness, for the distribution of the wheel load over the subgrade should be fully as great at the edges as at the center. Indeed, a good case might be made in favor of a greater thickness at the edge than at the center, because of the greater wetness of the subgrade near the edges of the pavment. Water, particularly from melting snow, will find its way underneath a narrow road pavement, to some extent, unless impervious shoulders are provided.

How Water Flows from Cuts Into Fills

The lower course of macadam or gravel road is frequently quite porous. When this is the case water will flow along the road from cut to fill; and, by saturating the fill in certain places, will cause "frost boils" in the spring. "Frost boils" do not occur on fills unless the fill is a clay that holds the water. In clay soils it is, therefore, frequently desirable to cut a V-shaped trench across the road at the end of every cut, with the point of the V uphill, and fill the trench with stone. This will intercept and divert any water that flows from the cut toward the fill. But if the fill is a long one, snow that melts on its shoulders may find its way into a porous layer beneath the pavement. In such cases weep-hole drains should be cut at intervals through the earth shoulders.

"Motor Trucks Are Admirable for Package Freight"

Hale Holden, President of the C., B. & Q. in a recent address before the National Industrial Traffic League, said:

> Motor trucks present an admirable means for effecting delivery of package freight to nearby points and I am satisfied that the railroads are prepared to join in reasonable measures to develop the use of them.

When the presidents of railway companies concede that motor trucks should be used to supplement railway transportation, isn't it time that highway engineers and city engineers begin to make themselves heard in loud protest against the curtailment of road and street work? Mr. Holden goes on to urge the necessity of supplying the railways with more capital that they may be able to carry freight more economically. Isn't it fully as important that the "feeders" of the railways—the roads and streets—be improved? Unless engineers and other men of foresight and public spirit take immediate steps to direct public opinion, there will be a reduction in the expenditures for roads and streets next year. Such a mistaken war-time economy will really be an extravagant saving that will cost the public heavily in the long run. Civil engineers should do all in their power, individually and collectively, to secure increased expenditures for city pavements as well as country roads in 1918; for the annual operating expenses of motor trucks vary directly with the character of the trackway over which they run.

To Welcome American Society of Civil Engineers

It was a gracious thought that prompted the societies of mining, mechanical and electrical engineering to welcome, with appropriate ceremonies on Dec. 7, the American Society of Civil Engineers to the engineering societies' building. These four great national societies, with an aggregate membership exceeding 30,000 engineers, are now housed in the enlarged building at 29 West 39th St., New York. Their four libraries are merged in one that is the finest and largest engineering library in the world. Nearly 12 years ago Engineering and Contracting repeatedly urged this fraternization of the four great national engineering societies. We rejoice at the final decision that has brought the civil engineers under the one roof with their brother engineers, and we doubt not that this action will lead to further co-operation for the common good of the engineering profession.

The Slow Progress of Road Improvement

Compared with previous years the expenditure of nearly $300,000,000 on county roads in 1916 was a huge sum, but it is really a startlingly small sum when gaged by the economic needs of the country. There are approximately 2,500,000 miles of roads, of which less than 300,000 miles are improved with some form of hard surface. The hard road mileage is increasing at the rate of 15,000 miles annually. At this rate it will take 150 years to give all the roads in America a hard surface. It is frequently said that most of our roads need never be surfaced, but those who make such statements have apparently ignored such facts as that not a mile of public road in England remains unsurfaced. Moreover, the advent of the motor car and motor truck have entirely changed engineering conceptions of to extent to which roads can profitably be surfaced with hard material.

Paint the Bridges White

It has long been the practice to paint road guard rails white, to increase their visibility at night. For the same reason at least the end posts of truss bridges should also be painted white. A truss bridge over the Iowa River on the Lincoln Highway has been painted entirely white, except the lower 4 ft. of the inner posts, braces and guard rail, which are black. It was thought that spattered mud would so discolor the lower part of the bridge that black paint would be preferable to white there.

The Road Bonding Bugaboo

There are about $400,000,000 of outstanding road and bridge bonds and warrants in America, or only $160 per mile of road. Yet we are frequently cautioned against the grave danger of overbonding for highway improvement. We are told that a road bond should never have a term longer than the "life of the road," by which is usually meant the life of the surfacing material. The plausible argument is made that the bonds should mature before renewals of the road surface become necessary.

What would our railway system be today if any such rule had been applied to railway construction? Railway ties last about 10 years and rails have an average life of about 20 years, but railway bonds usually have a life of 50 years—and then are refunded with other long-term bonds.

It is sophistical economics to argue that the term of a bond must be equal to or less than the life of a part of the plant. As a fact, the life of the entire plant—the road or the railway—is endless. If the renewal of its parts is paid for out of taxes or operating expenses, it is immaterial what the term of the bonds is.

A Motor Truck Subway?

The suggestion has been made that, to relieve the congestion in the "downtown sections" of large cities, it may become necessary to build subways for motor truck traffic. Why not? The street cars of Boston have their subways down town, and it can scarcely be said that street car traffic fills the streets to a greater degree than they are filled with motor vehicles. But prior to building subways, it is certainly imperative to pave all business streets with smooth pavements and to route the traffic of vehicles in a scientific manner. Traffic should be allowed to move only in one direction on the downtown streets during the busiest hours. Stringent rules as to unloading and loading along curbs should be adopted and enforced.

Cleaning Paving Brick for Relaying

In previous issues we have described the use of a pneumatic or air hammer, equipped with a chisel, for "toothing out" the half bricks left along the edge of a trench cut through a brick pavement. The same tool can be used for cleaning the grout off old pavers, preparatory to relaying them. A small portable air compressor driven by gasolene will supply air for two air hammers with which two men can clean grout off about 4,000 bricks in an 8-hr. day, or at the rate of 250 bricks per man per hour.

Only 25 Per Cent of All Roadwork Is Done by State Highway Commissions

Now that practically every state has a highway commission, it might be inferred that most of the expenditures for road work would be made under the direction of state highway departments. In 1916 a trifle less than $273,000,000 was expended (exclusive of about $15,000,000 of convict work) on roads and bridges in America, of which only $74,000,000 was expended by state highway departments. However, state road work grows proportionately greater every year, and the new federal aid law will serve to accelerate the relative increase in state road work.

Why is a Military Road?

To the Editor: Now is the time for all good men to discuss Military Roads and Priority Order No. 2, and I desire to submit for your attention a newly-expressed thought concerning highways and the relation of the war to them.

The United States is a young nation and we are a peaceful people. All our wars have been wars for the liberation for some class, people or principles. The development of the railroad came at such a time in the virgin growth of our nation that we neither wholly required nor appreciated the need of national or State highway systems. The more recent advent of the automobile, however, has awakened us to the benefits and necessity of improved roads for extending distances.

Roads in this country have never been designed or intended for military operations. In the Civil War the lack of good roads for those purposes was construed to be just another hardship in the gentle art of warfare, while in our Indian wars, the stage of the development of the frontiers and the nature of the enemy did not absolutely require nor permit the building of the proper strategic roadways.

In ancient times the best roads built by Carthaginians, Romans and the like were designed primarily for the purposes of conquest by the successful execution of military plans. The present excellent highway systems in Europe, however, were built with the idea of interior development, though it may be easily conjectured that the Huns, at least, preconceived their value for military activities. The uniqueness with which they served the purposes of warfare is marvelous, with the outstanding results in this country that some advocate similar road systems for strictly military purposes, while others, like a citizen of the West, fear to make the seaboard roads too good because they might be of service to invaders.

But just as the war of today is a war of chemistry, agriculture, food conservation, and other sciences and totally different from the war of manpower, shot and shell of years ago, so also are the military roads of today different from the military roads of Carthage and of Rome. To my mind, in this war and in all future wars, the military road begins at my neighbor's door. While it is true that the certain highways in time of invasion, in the event our railroad systems fail us, may be used primarily for the mobilization and maneuvers of troops, artillery and supplies, these highways will be few in number and mileage. Moreover, since this war is as much a war of food and other resources as it is of man power and ammunition, it is my conception of the road situation in America that every road in the land is a military road. It would be strangely inconsistent for us to proclaim that the bushel of wheat or pound of beef produced in some remote part of our land are war food which may win the war and at the same time fail to recognize that the road over which it may travel in order to get to our Allies or to our own people that some other foodstuffs may be sent abroad is intrinsically a military highway. World's commerce is not confined to the intercourse from port to port; neither does it begin at the factory or mill. World's commerce—according to a precise view—begins rather in the trap or seine, at the mine's mouth, in the lumber camp, on the ranch, or at the farmer's door. And world's commerce today is war commerce, which makes every highway in the land a military road.

While we may recognize the urgent emergency which prompted the issuance of a Priority Order No. 2 and may admit that coal is more important just now than sand, gravel, broken stone, etc., yet the situation may prove to be a relapse to the early war-cry of curtailing road and bridge work. Let us not forget that the development and conservation of our resources is unusually intimately connected with continued if not increased development of all of our highways. The earliest possible recession of the Priority Order No. 2 is the least that can be done for the good of the cause. In the meantime, let us let the good work for highway planning and improvement go on.

J. E. Kaulfuss, Highway Engineer.
State Highway Commission of North Dakota.
Bismarck, N. Dak.

Natural vs. Portland Cement for Pavement Bases

To the Editor: I have read your editorial entitled "Natural vs. Portland Cement for Pavement Bases" on page 85 of your issue of Nov. 7.

It seems to me that you have missed the point in this case. We all know that as soon as a road is improved with brick, asphalt, or any other type of pavement which requires a concrete base, or whenever a concrete pavement is constructed, there is immediately attracted to that road or pavement a larger volume of traffic and in the majority of cases vehicles of larger capacity, carrying much greater loads.

In New York State, where there is probably a greater percentage of improved roads than in any other state in the Union, the number of heavy motor buses, motor trucks and other heavy vehicles traversing the roads is increasing so rapidly that the maintenance department is hard pressed to keep roads in satisfactory shape.

The foundation of a pavement is its most vital part. There is a tendency on the part of engineers who are looking forward to the traffic which our roads must carry to increase the thickness of the base and in some cases to increase the richness of the mix used. Anyone who attempts to make this foundation just good enough for present-day traffic is liable to be criticized for failing to have anticipated the traffic of the future. We must build our roads with heavier foundations and build them in the best way we know how. The inability of the railroads to handle the traffic which is offered them has necessitated extensive use of motor trucks for handling freight. We must build our roads to meet this demand.

W. M. Kinney,
Engineer, Promotion Bureau, Universal Portland Cement Co., Chicago, Ill.

The following highway contracts have been awarded recently by State Highway Department: A. L. McCray, Los Angeles, for grading and concrete paving, 2.7 miles in Los Angeles County, at $111,251. Palmer & McBryde, Hooker & Lent Bldg., San Bernardino, for grading 15.6 miles in Humboldt County, at $223,556. Blanchard-Brown Co., New Call Bldg., 74 Montgomery St., San Francisco, for resurfacing with asphalt, Type A, 2.7 miles in Fresno County, at $22,824.

The New Kansas State Highway Administration Law

In the administration of highway work, there are certain things that a township can do more economically than a larger unit; others the county can handle to better advantage, while the systematizing and standardizing of the work throughout the state, the establishing of a uniform system of accounting and the collection and publication of cost data and information about road and bridge building materials and their use can best be handled by the state. The system of administration adopted by the Kansas Legislature of 1917 recognizes these three units, and definitely fixes the authority and responsibility of every official and extends from the State Highway Commission to the township road overseer. An interesting outline of the new system was given by Mr. W. S. Gearhart, State Highway Engineer of Kansas, in a paper presented at the recent meeting of the Oklahoma Engineering Society. The paper practically in full follows:

The State appropriates no money for highway construction and maintenance and can not until the State Constitution is amended. State appropriations can only be made for administration, engineering assistance and supervision. All road and bridge funds are provided by the counties, townships and benefit districts.

The State organization consists of a State Highway Commission, composed of three members of which the Governor is chairman. The other members are appointed by the Governor for a term of 4 years. The Commission appoints the State Highway Engineer and the secretary. All assistant engineers and clerks are appointed by the Commission on the recommendation of the State Highway Engineer. The salaries and term of office of all engineers and assistants are fixed by the Commission.

The Board of County Commissioners consists of three members elected for a term of 4 years.

The County Board of each county is required to appoint a competent county engineer for a term of 2 years. The appointment, however, must be approved by the State Highway Commission. The County Board can remove the County Engineer at any time for cause and the State Highway Commission can remove him for incompetency.

The County Engineer's salary is fixed by the population of the counties at from $1,200 to $2,000 per year and his traveling expenses. Two or more counties may unite and form a County Engineer district and employ one engineer for the whole district. This provision of the law has many advantages, for it enables the counties by uniting to employ the services of a high grade man and with an assistant in each county he can readily handle the work.

The township Board of Highway Commissioners consists of three members elected for a term of two years. The township board, with the approval of the County Engineer, is required to appoint, on his merits only, a competent experienced road builder as road overseer for the entire township. When the County Engineer deems it necessary, the overseer may appoint one or more competent assistants with the approval of the township board. No member of the township board can act as overseer or assistant overseer.

The State Highway Commission has general supervision over the administration of all road and bridge laws and over the construction and maintenance of all bridges and culverts in the State and of all county roads. The construction and maintenance work on all township roads must be done in compliance with the plans, specifications and general regulations prepared by the County Engineer in conformity with the requirements of the State Highway Commission.

The State Highway Commission is required to prepare standard plans and specifications suited to the needs of the several counties of the State governing the construction and maintenance of all highways.

The Commission is also required to devise and adopt a uniform system of auditing and accounting of all highway funds levied and expended, which system must be used by every township and county in the State.

The Commission is authorized to make investigations of the highway conditions in any county and to require the county and township officials to furnish any highway data desired, to assist in the defense of patent suits relative to road and bridge construction, and it is required to report any violations of the highway law to the Attorney General, who must take such action as is necessary to correct the same. The Commission is also required to take such steps as will give the provisions of the law full force and effect.

The County Engineer and the County Board are required to classify and designate the roads in their respective counties according to their relative importance as county roads and township roads.

The county roads are defined to be the main traveled highways connecting as nearly as possible the cities and market centers of each county with each other, as well as to connect with the county roads in adjoining counties.

In counties having a total of 1,000 miles of public roads or less, not more than 150 nor less than 50 miles, can be designated as county roads and any counties having more than 1,000 miles of public roads, not less than 10 per cent nor more than 15 per cent can be designated as county roads. All other public highways are township roads.

If any county fails or refuses to classify a system of county roads, the State Highway Commission has authority to make the designation and charge the expense to the county.

It is the duty of the County Engineer and the County Board in designating the county roads to eliminate all steam and electric road grade crossings and all other dangerous places so far as practical. The railroad companies are required to pay not less than 50 per cent nor more than 75 per cent of the entire cost of eliminating such crossings. The necessity for eliminating the crossings and the exact amount of the cost to be borne by the railroad company is determined by the State Highway Commission.

Two county maps showing the proposed county roads selected by the County Engineer and the County Board must be submitted to the State Highway Engineer for correction and approval. After the system has been approved, the County Engineer must name the county roads and divide them into sections, number each mile (numerical mile) of the several sections and make the necessary surveys to enable him to prepare a complete report to the State Highway Engineer as to the plan of permanently improving the county roads and all the bridges and culverts thereon. The survey and report must consist of an accurate plan and profile of the county roads showing cuts and fills, surface and lateral drainage, sub-drainage, soundings of foundations for each bridge and culvert and an estimate of the watershed. These plans and reports must be passed upon by the State Highway Engineer and in doing so, he must take into consideration the thoroughness, feasibility and practicability of such plans and approve or modify the same. After the plans for each section of road are approved by the State Highway Engineer, they must be filed and the County Board must then proceed to construct the roads, bridges, culverts and drainage work in accordance therewith.

The County Commissioners of each county are required to make an annual levy of not less than ¼ mill nor more than 1½ mills on the dollar on all the taxable property of the county for the construction and maintenance of the county roads. This fund can not be expended for bridges or culverts. The earth approach fills to bridges and culverts, however, must be paid for out of the road funds.

The County Board is charged with the administration of all county road matters and acts for the county in about the same capacity as a board of directors for a bank or railroad, but the County Engineer has direct charge and sole responsibility for the actual construction and maintenance work.

When all the county roads and the bridges and culverts on the county road system have been permanently improved according to the approved plans and the county has sufficient funds available, other roads may be added to the county road system, following the same procedure as before, but no increase shall be made in the mileage of county roads until the original county system is completed, unless by a majority vote of the electors of the county it is decided to adopt the county as the road unit, in which case the highways must be classified according to their relative importance and then all roads, bridges and culverts in the county must be constructed and maintained at county expense by the County Board under the direct supervision of the County Engineer.

The township is required to construct and maintain all township roads and all bridges and culverts on the township road system when the County Engineer's cost of such structures does not exceed $300. The construction and maintenance of the township roads are under the direct supervision of the road overseer subject to the general directions of the County Engineer and the township board. The relation of the overseer to the township work is practically the same as that of the County Engineer on the county system.

All road work must be done timely and in accordance with the requirements of the State Highway Commission. The County Engineer and the County Board determines when and where the work shall be done upon the county roads and the County Engineer and the Township Board must determine the same on the township roads.

The County Engineer, with the approval of the Township Board, determines what township roads can be dragged, which must include all graded rural mail routes and each year he must contract with or employ persons to drag these roads at such time and upon such terms as the board and the County Engineer may direct. With the approval of the County Board, he must decide what county roads can be dragged and arrange each year to have them dragged at such times and upon such terms as the board and the County Engineer may decide. Upon the recommendation of the County Engineer, the patrol system of maintenance may be adopted on either the county or township system. Any officer refusing or neglecting to enforce the provisions of the drag law subjects himself to a fine of not less than $10 or more than $250.

Surfaced roads may be financed: First, from the county road funds; second, by voting a special annual tax; third, by county bonds authorized by a majority vote of the electors; fourth, by the Benefit District plan.

The boundaries of the benefit district may be fixed in any manner desired so as to include as nearly as practical all the lands specially benefited. The system is a modified form of the drainage district law.

A legal petition is one signed by 51 per cent of the resident land owners (resident of the county) owning at least 35 per cent of the land or by 35 per cent of the resident landowners owning at least 51 per cent of the land, or by the owners of at least 60 per cent of the land.

The County Board must determine whether or not the proposed improvement is of public utility and if they declare it to be, they must then allow the petition.

The plans must be prepared by the County Engineer or by some other competent engineer and the construction work must be done under his direction. The plans, specifications and estimates of the cost must be approved by the State Highway Engineer before they are adopted. Federal aid construction work must, of course, be carried out under the direct supervision of the State Highway Commission.

The cost of the improvement is apportioned as follows: After the Federal aid, if any, and all donations are deducted, the remaining cost is apportioned 50 per cent to the county, 25 per cent to the township or townships in which the benefit district is situated, divided according to the area of the benefit district in each township and 25 per cent among the several tracts of land within the district, the assessments being made according to the benefits that accrue to the real property and the improvements thereon. The special assessments against the property in the district may be paid at the time the work is completed, or in from 10 to 20 annual installments.

All county and township bridges and culverts, railroad overhead crossings and subways, must be built according to the standard specifications prepared by the State Highway Commission.

The township roads, bridges and culverts are all financed out of the township road fund, but the County Board is required to make an annual levy in August for the construction and maintenance of the county bridges and culverts and this levy can not be used for any other purpose. The budget system must be used in making this levy and between April and July each year the County Engineer is required to inspect all the bridges and culverts in the county and prepare an estimate of the cost of all repairs and maintenance of each existing bridge and culvert necessary to keep the same in a reasonably safe condition for public traffic and prepare a report and file it with the County Board on or before the July meeting. The report must give the exact location, the character of the repairs and the materials that should be used and the estimated cost of repairing and maintaining each structure.

At the June meeting the County Board must determine what new bridges and culverts shall be built during the ensuing year, the kind of materials to be used and the location of each bridge and culvert and furnish a copy of the same to the County Engineer. The County Engineer must then visit the sites of all proposed new structures and prepare plans, specifications and estimates of the cost for the same and submit them, together with his recommendation, to the County Board on or before their July meeting. Based upon the County Engineer's estimates and recommendations, the County Board must determine the amount of taxes which, in its judgment, should be raised for such repairs and new construction.

Before the levies are finally determined upon, however, the County Board must hold a public meeting and hear protests, if any, against the levies and the bridge and culvert improvements contemplated. The public notice of the hearing must give the location of each structure which the board proposes to build or repair, the character of the construction or repairs to be made and the estimated cost. After the termination of the hearing the County Board must make an order and spread the same upon its journal stating the exact location of each bridge and culvert to be constructed or repaired, the character of the construction or repairs contemplated and the amount of money appropriated for each such bridge or culvert.

To the tax so determined, an amount equal to 20 per cent of the same must be added for a contingent fund to reconstruct or repair any structures which unforeseen contingencies may make necessary.

The County Board is also authorized to call an election at any time to vote bonds for the construction of one or more bridges.

The plans and estimates for all bridge and culvert work must be prepared by the County Engineer, but the County Board may employ a consulting engineer to act in conjunction with him in preparing plans and estimates and supervising the construction. No engineer shall be employed by the board, however, to furnish or prepare plans or estimates for any bridge or culvert work or to supervise the construction of any such work who is in the employ of, or who represents any bridge company, bridge firm or bridge contractor.

The State Highway Engineer must approve the plans for all bridges and culverts the estimated cost of which is more than $2,000. The plans for all bridges costing less than this amount must be approved by the County Engineer.

It is made the duty of the County Attorney to personally examine all the proceedings of the County Board in the letting of bridge and culvert contracts and no contract is legal and binding on the county until he has approved the same.

The County Engineer has direct charge of all bridge and culvert construction and maintenance work and whenever he deems it necessary, he must appoint, with the approval of the board, a competent inspector to supervise the work and he can remove such inspector at any time for cause.

All township highway bills must be approved by the township road overseer and all county highway bills must be approved by the County Engineer before they are allowed by the boards.

The township road overseer on the township road system and the County Engineer on the county road system must keep an accurate account on the forms prescribed by the State Highway Commission, of all labor and materials used in the construction, repair and maintenance of each and every bridge, culvert and mile of road. For this purpose, all the roads are divided into sections and miles (numerical miles). The overseer and the County Engineer must make a careful itemized sworn report of all highway expenditures to the State Highway Commission each year.

Heretofore the townships have kept practically no records at all and it has been impossible to determine the total amount of highway funds expended even approximately correctly.

The County Engineer is required to keep an open ledger on each bridge and culvert in the county so that the original cost and the maintenance cost to date can be determined on any structure at any time. When it is necessary to repair these structures or decide upon the materials and type of new construction to be used, this information will be of great value.

An act without a penalty for violation of it simply encumbers the statute books. The Kansas Legislature realized this and provided the following penalties for violation of any of these road and bridge statutes: "That any person who shall violate any of the provisions of this act shall be deemed guilty of a misdemeanor, and upon conviction thereof before any court of competent jurisdiction shall be fined a sum of not more than $500, and shall be committed to the county jail until such fine and cost of prosecution be paid."

"That any officer who shall violate any of the provisions of this act, or who shall fail to perform his duty as required by this act, shall be deemed guilty of a misdemeanor and upon conviction thereof before any court of competent jurisdiction, shall be fined a sum not less than $25 nor more than $1,000 and shall forfeit his office, and it shall be a part of the judgment of the said court before whom the case is tried that such person be removed from office and that he stand committed to the county jail until the fine and costs of the prosecution are paid."

The State Highway Commission has authority to employ division engineers, but does not have the necessary funds. The lack of sufficient appropriations to properly support the State Highway Commission at this time is the worst drawback to the Kansas system. The Iowa Highway Commission has had liberal appropriations each year and since the new system was adopted in 1913 the Commission has maintained five to six district engineers in charge of the work in 15 to 20 counties assisting the county engineers and co-operating with them. States like Kansas and Oklahoma are too large for all of the work to be handled economically and to the best advantage from one central office.

A 1,000 Sq. Yd. of Asphaltic Concrete Per Day.—An excellent record in road building was made in connection with the army cantonment near Louisville, Ky. This is one of the few military establishments that have built permanent roads. In 63 working days the contractor completed 63,360 sq. yd. of Trinidad asphaltic concrete highway laid on a concrete base, or about 6 miles of road 18 ft. wide. A mile of the road was over a 4-ft. fill, and immediately upon its completion a traffic count showed that 4,000 vehicles passed over it within the first hour. Most of these vehicles were motor trucks and wagons carrying loads of from 1 to 5 tons. The record made by the Bickel Asphalt Paving Co., Louisville, Ky., the contractors, is all the more remarkable in view of the fact that it was necessary to haul and crush all the stone used on the work.

Two-Course Concrete Road Construction by Wayne County, Michigan

All of the concrete roads constructed during the year ending Sept. 30 by the Road Commission of Wayne County, Michigan, with the exception of two emergency roadways, have been of the 2-course type. This departure from the more recent practice of the county was due to difficulty in getting a sufficient quantity of stone that met requirements. The specifications now provide for Wisconsin granite or trap rock for the wearing course and washed pebbles or crushed limestone for the lower course.

In the last annual report of the Commission the following statement regarding the change is made: "Other things being equal our preference is for 1-course work construction, as the 2-course work is more expensive in the labor items and in the cost of the coarse aggregates used for the wearing surface. However, we believe that through the uniformity of the quality of the trap and granite, we are justified in making the additional expenditure predicated on our roads lasting for a much longer time.

A typical cross section of the 2-course road is shown in Fig. 1.

A material change also was made this year in the specifications by which the width of the expansion joint was increased from ¼ in. to ½ in. It had been found in several instances that roads 6 and 7 years old had buckled at the joints and several slabs had slipped over the top of the adjoining sections. The width of the expansion joint was increased as a precaution against future occurrences of this kind.

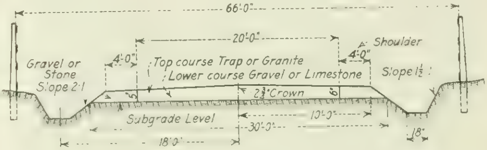


Fig. 1—Typical Cross Section for 20-Ft. Paved Roadway.

The requirements in the 1917 specifications for joints and concrete are as follows:

CONCRETE.

The proportions for the bottom course shall consist of 2 parts cement, 4 parts of fine aggregate, and 8 parts coarse aggregate, 4 in. thick, evenly and thoroughly mixed—parts of cement, fine aggregate, and coarse aggregate, to be determined by measurement. Aggregate for wearing course shall consist of: Hard, tough, durable, crushed granite or trap rock—with a French coefficient of wear of at least 16, graded in size, free from dust, loam, vegetable or other deleterious matter and shall contain no soft, flat or elongated particles. The size of the coarse aggregate shall be such as to pass, when dry, a 1¼-in. round opening, and be retained on a screen having ¼ in. openings. In no case shall the coarse aggregate contain frost or lumps of frozen material. The wearing course shall be mixed in the manner hereinbefore specified, in the proportions of 2 parts cement, 3 parts fine aggregate, and 5 parts coarse aggregate—3 in. thick. The wearing course shall be placed immediately after mixing, and in no case shall more than 30 minutes elapse between the time the concrete for the base has been mixed and placed and the time the wearing course is placed.

JOINTS.

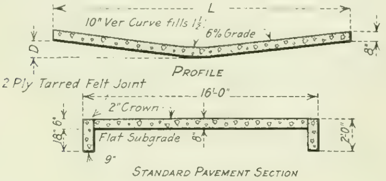
Transverse joints shall be not less than ⅜ in. nor more than ½ in. in width and shall be placed across the pavement perpendicular to the center line and 25 ft. a part. When a curb is specified or where pavement abuts a building, a joint ¼ in. wide shall be placed between it and the pavement. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to its surface.

The concrete at transverse joints shall be protected with soft steel joint protection plates which shall be rigidly anchored to the concrete. The installation of the metal protection plates shall meet with the approval of the engineer. The surface edges of the metal plates shall conform to the finished surface of the concrete, as shown on the plans attached thereto.

All joints shall be formed by inserting during construction and leaving in place, the required thickness of joint filler which shall extend through the entire thickness of the pavement.

Paved Crossings for Carrying Water Over Roads

Paved crossing for carrying water over roads are used to a considerable extent in Southwestern states. The type employed in Pottawatomie County, Oklahoma, is shown in the accompanying sketch. In a paper presented at the recent meeting of the Oklahoma Society of Engineers, Mr. L. L. Winans, County Engineer of the above mentioned county, stated that concrete paved crossings were economical for drainage areas from 20 acres up where there is either a very small shallow channel or no channel at all and where the grade of the adjacent hills is less than 5 per cent. The crossing should be built of sufficient length to give the necessary waterway with a maximum grade of 6 per cent and a maximum depth of water of 1½ to 2 ft.



DIMENSIONS							
L Ft.	D Ft	Concr Cu Yds	Water way	L Ft	D Ft	Concr Cu Yds	Water way
	.03L-.15	.45L			03L-.15	.45L	1.5(L-25)
20	.0'-5½"	9 0	6.0	50	1'-4¼"	225	375
25	.0'-7¼"	11 5	9.2	60	1'-6"	270	52 5
30	0'-9"	13 5	13 4	80	1'-6"	36.0	825
35	0'-10¾"	15.7	18 3	100	1'-6"	450	112 5
40	1'-0¾"	18.0	24.0	150	1'-6"	675	1875
45	1'-2½"	20.2	29 6	200	1'-6"	900	262 5

Standard Paved Crossing for 16-Ft. Roadway.

In the Pottawatomie County crossings all concrete below subgrade in cutoff walls is a 1:2½:5 mix; all other concrete is a 1:1½:3 mix. Contraction joints of 3-ply tarred felt are placed not more than 30 ft. nor less than 20 ft. apart and at right angles to the road.

Extension of Time for Completion of Highway Contract

In order to relieve contractors of responsibility in the event they are unable to obtain delivery of road material on account of Priority Order No. 2 forbidding the use of gondola cars for shipment of stone, gravel, etc., the State Highway Department of Pennsylvania appends the following note to its proposal sheets:

> In the event of the contractor being unable to complete the contract within the time specified, due to his inability to secure labor or material, or on account of conditions over which he has no control, the commissioner will, upon satisfactory proof thereof, grant an extention of time commensurate with the facts established.

The Commissioners of Sacramento County, California, are calling for bids for constructing 13 miles of concrete paved highway.

Need of Centralization in Highway Control

An interesting discussion of the importance of a central control of highway work was given by Mr. Logan Waller Page, Director of U. S. Office of Public Roads and Rural Engineering, in an article in the first issue of Kansas Highways, the official publication of the Kansas State Highway Department. Mr. Page's article follows.

The State of Kansas has 111,000 miles of public roads, on which were expended last year nearly $6,000,000. How much of this expenditure gave the state 100 per cent returns in improved transportation we do not know. One thing, however, is certain, no engineer or business man in the world, if given this sum of money with which to maintain this mileage, would begin by creating 105 absolutely independent and unattached administrative divisions, and then still further divide these in the manner in which the highway administration has in the past been divided in Kansas.

Road improvement is a public undertaking, the wisdom of which must be measured by the resulting benefits. Not all road improvements pay dividends. If they did there would not be the crying need for more efficient administration, skilled supervision and scientific procedure in all lines of road work. A community can pay too much for a road improvement in the same way that a prospective farmer can pay too much for a farm. Furthermore, a farmer may, through ignorance or carelessness, purchase a farm entirely unsuited to the kind of agriculture he wishes to carry on. In the same way a community may adopt a type of road improvement entirely unsuited to the particular traffic requirements.

A road improvement, to be justifiable, must give reasonable promise of returning, in social and economic benefits, an annual return at least equal to the sum of the interest, depreciation, and maintenance charges over and above those on the old road. It is therefore plain that over-investment, as well as under-investment, is possible in regard to road matters, much the same as in ordinary business undertakings. The amount which, therefore, can be and ordinarily should be invested in the improvement of any given road is that sum which will give the largest net annual returns in social and economic benefits during the period which may be considered as the most probable life of the improvement.

The basic proposition upon which our road building and maintenance must ultimately rest is that the character of the road and the amount of money expended for its construction and maintenance must be determined by the service which the road renders. For example, it may be genuine economy to allow an annual cost outlay or charge on one road of $2,000 per mile, and only $100 per mile on another, because in the former case the service rendered may be twenty times the service rendered in the latter case. The proper and systematic classification of our roads in regard to the character and amount of the traffic which they carry has hardly been more than begun as yet, even in our most progressive States. Before undertaking any general scheme of road improvement it is the duty of the State, as well as local subdivisions, to make such traffic studies as will determine a proper highway system, the order in which they should be improved, and the character of construction and maintenance best adapted to properly and most economically meet the traffic requirements of each road.

In the State of Kansas it is probable that about 20 per cent of the total road mileage of the State carries at least 75 per cent of the traffic, and that about 7 or 8 per cent carries at least 50 per cent of the total traffic. In fact, the traffic volume and its source and distribution on our public roads may be compared with the run-off from the drainage area of a river system. Rills, creeks, branches and main streams of the river system find their counterpart in byroads, neighborhood roads, feeders, main roads and trunkline roads of a highway system. Each of these several parts are definitely interrelated and plays its special part in the functioning of the whole system. Like the water in the rills of a river system, traffic first gathers in small or insignificant volume on the local roads or feeders, and then gradually uniting and increasing in volume, flows towards its outlet or destination.

Here, however, the analogy presents a striking difference. Whereas in a river system the flow automatically develops and maintains its channel, the passing traffic on the highway system, in order to flow freely, must have a way artificially prepared and maintained for it. Moreover, to be efficient, each of the roads in a highway system must conform in location, improvement and maintenance to its own particular traffic requirements and physical conditions. This absolutely requires some definite State-wide authority for co-ordinating the various parts. In the past we have tried every conceivable form of unlimited local control without success. By a slow process of elimination, trial and experience in various States we have found that the only practical solution is a State highway department with sufficient powers and resources to co-ordinate the road work of the entire State.

The last session of the Legislature of the State of Kansas created such a State highway department. Because of certain constitutional restrictions which remain as yet unamended, the activity of this department, as compared with that of some of our other States, must of necessity be somewhat circumscribed. The powers and duties with which it is endowed are, however, sufficiently broad to insure a real success. I, therefore, most earnestly advise all the county and township officials to make the fullest use possible of their State highway department. The real measure of success of the State highway department, measured in terms of better roads and improved transportation conditions, will be found, not in the isolated action of the State highway department, but in the use which the county and township officials and the people at large of Kansas make of their State highway department.

Road Bond Issues by Texas Counties.—A number of counties in Texas have recently voted bond issues for road purposes. Among these counties are the following: Hunt County, $30,000 for road in White Rock Precinct; Dickens County, $400,000; Freestone County, $50,000 for Road District No. 8, and $20,000 for Road District No. 2; Titus County, $50,000 for Cooperville District; Nolan County, $100,000; Anderson County, $50,000 for Frankston Precinct and $40,000 for Cayuga District. Bond issues are to be held shortly in the following counties: Callahan County, Dec. 21, $100,000; Fisher County, $250,000.

Proposed Method for Maintaining a County Road System

A combination of patrol system, convict labor and district gangs for maintaining the road system of Dallas County, Texas, has been recommended by J. F. Witt, County Engineer, in a report to the County Commissioners. The plan calls for the maintenance of 600 miles of gravel surfaced roads and 800 miles of dirt roads, divided into four districts. The total income from the road and bridge tax for this work is $200,000 or $50,000 for each district.

Under Mr. Witt's plan it is contemplated that the 200 miles of dirt roads would be maintained by convict labor. For this work for each district the necessary expense is estimated to be:

For convict camp expense for one year	$ 8,500.00
Bridge lumber for one year	2,000.00
Road graders, drags, fresnos, plows, repairs, etc	1,000.00
Total	$11,500.00

Deducting this $11,500 from the $50,000 would leave the sum of $38,500 for use on the 150 miles of surfaced roads, which gives a general average of $256 per mile per year. This $38,500 would be apportioned approximately as follows:

25 miles at $600 per mile per year	$15,000.00
25 miles at $300 per mile per year	7,500.00
100 miles at $160 per mile per year	16,000.00
Total	$38,500.00

The above total would cover the organization outlined as follows:

General superintendent of maintenance and auto at $150 per month, or $1,800 per year, or per district	$ 450.00
Regular district supervisor at $125 per month	1,500.00
District gang, 8 teams, 250 days per year at $4 per day per team	8,320.00
Lumber for bridging	1,000.00
One auto truck and trailer	1,250.00
Note.—The auto truck and trailer would cost $5,000, which would be $1,250 for one district.	
Two men on truck, gasoline, oil and repairs, 250 days at $10 per day, $2,500, one district	625.00
Steam or gasoline roller, 100 days at $10 per day	1,000.00
12 road keepers at $85 each per month	12,240.00
Extra teams on grader, with road keeper	2,000.00
Local gravel, 14,400 cu. yd. at 25 ct	3,600.00
Shipped gravel, 2,000 cu. yd., at $1	2,000.00
Crushed stone, including screening, 1,000 cu. yd., at $1.75	1,750.00
Bituminous top, 26,400 gal., at 10 ct	2,640.00
	$38,375.00
Difference	125.00
Total	$38,500.00
Available, $38,500.	

The General Superintendent, who would be a man skilled in the maintenance of roads, would cover the 600 miles of surfaced roads in the county every 6 to 10 days. He would be directly responsible to and would be governed by the Commissioners' Court. He would see each man on the work at least once in 10 days and would be able to instruct every man in his jurisdiction as to the method to pursue to obtain the best results. He would have full power to employ or discharge the roadkeepers, men in the 8-team gang, or with the truck or roller; without this power his efficiency would be reduced materially.

By employing a general superintendent, methods of maintenance would be standardized, enabling each Commissioner's District to receive a direct benefit from the general system. The regular District Supervisor could proceed with his duties as at present and could advise with, but he would not in any way interfere with the authority of the general superintendent.

The district gang, consisting of 8 teams and drivers, would haul all material to the road, depositing the same at convenient places along the roadside, thus allowing the regular keeper to work on the road proper at all times. They would do all heavy work, keep all unloading bins filled with gravel, or crushed stone, and patrol at intervals the 50 miles of roads that other keepers are not provided for. This 50 miles will be the lightest traffic carrying roads in the district.

The automobile truck is considered essential on long hauls. Trap bins would be erected at proper location—these bins to be kept filled with gravel by the 8-team outfit. Economy would demand that the truck be moving practically at all times. The truck should be of the broad steel tire type, tires on the rear wheels to be not less than 15 in. in width. The broad tires could act as a roller to compact all patches as they were placed. They would also minimize the load per square inch as applied to the road surface, prohibiting unnecessary ware by a machine that is intended to improve the road instead of wearing it away. The original cost of the truck and trailer is divided between the four districts.

All road building material would be purchased by the Commissioner's Court in quantity sufficient to get the best prices and on a competitive bid basis when practical.

Roadmakers (patrols), would be placed as follows: On the heavy traffic roads near the city, five keepers at 5 miles each, 25 miles. For the next important roads, three keepers at 8 1/3 miles each, 25 miles. For the light traffic roads, four keepers at 12½ miles each, 50 miles, or a total of 100 miles. The other 50 miles of light traffic roads are to be patrolled at intervals by members of the 8-team squad, as heretofore set out. By having the material for patching and surfacing the roads placed at convenient places along the roadside, the keeper would be on the road proper at all times, and as elsewhere noted he would have an extra team available when necessary for use on the grader or drag. The roadkeeper would wear a distinct type of hat of uniform color and should have a flag or other marker of the same color to be displayed on the road side when he leaves the road for any purpose. This marker would inform the general superintendent when on his rounds of the keeper's location, insuring the superintendent seeing each keeper on every trip he makes.

Cost of Tarvia Treatment at Queen Victoria, Niagara Falls, Park System

About 28,000 sq. yd. of the Niagara River Boulevard in the Queen Victoria Niagara Falls Park System, Ontario, were given a surface treatment with tarvia A in September, 1916. The cost of the work was 6.6 ct. per square yard, according to the last annual report of the Park Commission. The average haul was 1½ miles, and the surface treated was 18 ft. wide and 14,000 ft. long. About ¼ gal. of tarvia was applied per square yard of surface. The detailed cost of treatment was as follows:

Labor.	Total.	Per sq. yd.
Teaming, ½-in. stone	$ 192	$0.69
Loading and spreading stone	157	.56
Sweeping and brushing roadway	29	.10
Heating tarvia	113	.40
Distributing and rolling	27	.10
Miscellaneous	24	.09
Total	$ 543	$1.94
Materials:		
½ in. stone chips, 348 tons at $1.10	$ 383	$1.37
Tarvia A, 6,500 gal. at 10 ct	650	2.32
Freight, $115; car service, $19	134	.48
Coal, 19.7 tons at $7	138	.49
Total	$1,305	$4.66

Teams were paid for at rate of 45 ct. per hour; laborers received 20 ct. per hour and foremen 30 ct. per hour.

Road Work on the Punitive Expedition into Mexico

The route used for the supply of the Pershing punitive expedition into Mexico was probably the first natural road of such length that was ever subjected to motor truck traffic on a large scale. In the November-December Professional Memoirs, Capt. Ernest Graves, U. S. Corps of Engineers, describes the methods that were used in keeping this road passable for the trucks. Extracts from Capt. Graves' paper follow.

The supply of the military force was accomplished by means of truck trains and wagon trains and by means of shipments on the railroad from Juarez, Mexico, to Colonia Dublan, Mexico. Only two or three wagon trains were used, while 10 or 15 truck trains were constantly used. It is estimated that at least an average of one truck train (consisting of about 30 trucks) a day passed over each point in the road each way, making about 60 trucks over any one point per day. The trucks used were of many types, varying in capacity from 1½ tons to 4 tons. However, after the first stages of the expedition, 1½-ton trucks were the ones used mostly. This means that the road was subjected to traffic which produced a wheel pressure of from ¾ ton to probably about 2 tons. Of course, this traffic made the road work exceedingly difficult.

The route over which the supplies were carried varied a good deal. One road was used until worn out and then traffic was shifted to another. This shifting was both general and local. Practically the entire road to El Valle (180 miles) was changed and local changes were made where bad spots developed.

The road first used consisted of a natural trail, which generally followed a level plain in a river valley, but at several places passed through mountain passes from one plain to another. At some places the trail ran through the mountains for distances of from 30 to 35 miles. This route was first used. Later, when it became evident that the expedition would remain in Mexico during the rainy season, the route was changed.

Both of the routes passed through a route devoid of timber. There was absolutely nothing that could be used for bridges; i. e., nothing that would last any length of time. Most of the stream beds were dry the greater part of the time, and generally no crossings were necessary because the arroyos never had water in them for more than a few hours at a time. The exceptions to this were the Casas Grandes River, the Santa Maria River, and irrigation ditches in the towns. Even these rivers were fordable, except during parts of the rainy season.

When the new route was first decided upon it was not known just how much work could be completed before rain, so different expedients appeared advisable in different localities. From Columbus to Vado Fusiles (19 miles) there was already a trail, but as it passed over flat undrained country it appeared best to place the road on an old railroad grade which had been in existence for years. This grade had to be patched in places, and small bridges and culverts had to be put in. From Vado Fusiles south for about 16 miles an existing trail passed over a flat country which was not drained, and which required grading. Then it went through some hilly country in which drainage was comparatively easy. From these hills the existing trail passed down into the flat country containing Ascencion, Ojo Federico, and some lakes. This trail was used for a while, but later a road was located on new ground along sloping hillsides. It went around the flat country, and came to the existing trail near Ojo Federico. This new road had to be cleared of mesquite. In it there were long stretches of fine sand which were almost impassable for trucks in dry weather.

From Ojo Federico the road followed the existing trail to Capuchin Pass, from which point it left the old road and followed the sloping hillsides, to the eastward, to Corralitos Station. A portion of this stretch had to be cleared of mesquite. From Corralitos Station a new road was made to Dublin, alongside of the railroad.

At first it was not expected that grading would be done all along this route. In fact, south of Ojo Federico no new route was laid out. The existing trail for about 24 miles north of Dublan followed the Casas Grandes River, and was flat and undrained. Since it did not seem possible that grading could be accomplished here and since the road would most certainly be muddy, something had to be done. So a battalion of the 24th Infantry with hired native teams went to work to put gravel on the existing trails, which had already worn into two deep ruts. Gravel was hauled from the river bed, which was almost dry. Before it was possible to start the new grade in this section the 24th Infantry had put 4 in. of gravel on this entire section. The gravel did not pack readily, and was used by trucks only when they were forced to it. It came into use again after the rainy season.

Finally, all of the route and in addition 10 miles south of Dublan (total 130 miles) had to be graded. Even the railroad grade from Columbus to Vado had to be graded in places. In grading no attempt was made to follow the existing trail, even when it was close by. A new line was laid out which was made as nearly straight as possible, and the least possible number of changes in direction were made. The machines used could work to much better advantage in straight lines, and maintenance of straight lines was easier. The road in places would be straight for a length as great as 15 miles.

At first several different kinds of graders and tractors were used. In places scrapers were used. Steam rollers were tried on the grade before wet weather and after wet weather. All of the tractors tried proved too frail and of little use, except the caterpillar tractor. Small (6-ft. blade) graders could be used with tractors, with trucks, or with teams. The large (12-ft. blade) graders pulled by a caterpillar tractor proved to be the thing to use.

The work of grading, when finally unsuitable machines were discarded, was done simultaneously in the three sections by the three companies, "E" Co. had 2 tractors in the vicinity of Vado, "G" Co. had moved to Ojo Federico and had 3 tractors in that vicinity, and "H" Co. had moved to Dublan and had 1 tractor in that vicinity.

The grading work was done both in the vicinity of water and far from it. Since the machines used gasoline and required only a few men to operate, the water supply question was not exceedingly difficult. Long stretches (25 miles, for instance), were graded, water for the men being carried by trucks. Three graders could start out with crews and 4 Jeffery trucks could follow along and bring enough camp equipage, gasoline, water, etc., for the crews. Water could be carried in a tank wagon towed by a Jeffery truck. When supplies gave out, trucks could be sent for them.

In grading a long stretch it was very essential to economy in work and time, that there should be a minimum movement of tractors when not actually grading. It was unnecessary to lose time moving back and forth from camp, if the place where tractors would be at night was carefully computed in advance, so the camp could be located there. Usually the grading did not stop until dark, so camp and food must be provided for the crew when it arrived. Of course, the machines had to be in camp at night where the guard could keep them from being tampered with. On one occasion a tractor was left out over night and the next morning it had been disabled by some meddler.

A gasoline caterpillar pulling a large (12-ft. blade) grader could grade as much as 2 or 2½ miles of road per day, provided there was no mishaps. Apparently the most important thing that a novice could look out for to prevent a breakdown was lubrication. If the machines were kept properly oiled, they were likely to keep running. They were operated by both civilians and by soldiers, whichever were available. One had to try anybody who said he could do it. Of course, one machine rarely graded 2 miles a day. Mud, sand, breakdowns, etc., frequently prevented any progress at all in one day. On one occasion Lieutenant Somervell graded from Capuchin Pass to Corralitos Station (about 22 miles) in five days with two graders, each being pulled by a tractor.

The 12-ton Holt tractors, which proved the most successful of any tractor used on the road work, have a bearing pressure on the ground of about 7 lb. per square inch. These machines will pull a load through mud or sand in almost any condition. However, even these tractors encountered places where they would not work. On one occasion, a tractor pulling a grader just south of Dublan simply sank down in the mud and could not get out. A little ingenuity often could save much time. On the occasion referred to, after an entire half day had been spent in moving about 400 yd., it was found that the muddy places could be gotten over as follows: Fasten the grader close up to the tractor and grade, watching the tractor caterpillar wheels closely. Just the second that these wheels begin to slide on the soft ground, stop before sinking begins and unchain the grader. Without the load the tractor will go over the soft spot. Then fasten the chain extended and proceed with the grading until grader is across the soft spot, when grader can be chained on again, close up. The time lost changing chain connections will be nil compared to that lost by getting tractor down in mud. Frequently, grading can be done with a long chain which allows grader to be steered where desired without tractor having to go directly in front over soft ground.

Care should be taken not to make the crown too high, so that there is too much freshly cut earth to pack. The lower the crown, provided it drains, the quicker will it bear traffic. It is necessary that a dirt road be this width for trucks to stay on it and not to ruin it the first time they go on it. On any narrower grade the trucks will be continually sliding off, and, in addition they will push the graded material into the ditches.

This grade can be put up by 7 or 9 cuts with a 12-ft. grader. This is done by two cuts to make each ditch, one cut on each side throwing material to the center, and one trip down the center scraping the top smooth, total seven trips. If the width is not carefully made or if the work is not carefully done, two more trips (one on each side), are necessary to throw earth to the center. This method works in soil comparatively soft and firm. Harder materials, as well as muddy materials, require more work.

The graded road to Dublan was finished about Aug. 5, just before any heavy rains occurred. Later, after the road became impassable farther south the road was graded about 10 miles south of Dublan.

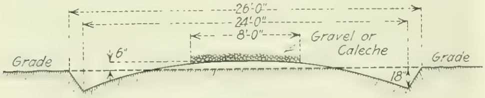
South of this grade the road ran on hilly ground to El Valle (about 50 miles), and no attempt to grade was made. This road had been selected with a view to travel in rainy weather and was well drained. Long stretches of it were originally on unbroken ground which was soft at first, but developed into a pretty fair road when traveled over after moistened by rain. Of course, there were many arroyo crossings which had to be sloped and paved because of lack of bridge material. Places had to be crossed which required a continuous paving of 2-man stone.

At San Joaquin, the San Joaquin River (dry most of the year) had to be crossed by sloping the banks and paving the bottom. Once or twice after heavy rains this crossing developed into an impassable ford.

On the whole, the road south of the grade to El Valle was very good during the rainy season. In dry weather it got dusty and rough.

At El Valle the Santa Maria River was crossed by a trestle bridge about 150 ft. long and a rock causeway about 1,000 feet long.

South of El Valle the road ran through hills and mountains all the way to Namiquipa, about 60 miles. There were many arroyo crossings, both large and small. It appeared fairly certain that these arroyos could not remain impassable for more than a few hours at a time, so no bridges were absolutely necessary. Whatever the necessity, no material for bridges could be obtained. The road in this section could be fixed for rainy weather, because there was rock and gravel close by any locality that needed it. The steep rocky hills would, of course, be better with occasional rains than in dry weather. So when orders were received to prepare the road for the rainy season, gangs of native wagons were put to work placing stone and gravel on the stretches where water would produce mud.



Cross Section of Road.

In places where water was near by the proposition was fairly simple, although the load that a native wagon would carry was ridiculously small. The mules, which pulled the wagons in teams varying from 4 to 6, were small, lean, poorly fed, and in many cases crippled. The wagons were generally almost in a state of collapse. If the team and wagon could carry a load varying from ½ to ⅔ yd. on level ground, frequently the pull out of a stream bed where gravel was obtained would make the loads actually hauled even less. The cost of such work at $5 per team per day was too large to allow anyone to keep track of it.

However, the proposition in all the stretches of southern section was not so simple. There were length 8 to 10 miles long in which no water could be found for men or animals. The only possible solution was to camp the men and haul water to them. Trucks could not be gotten in sufficient numbers to haul gravel, but a few trucks were available for hauling water. The teams simply had to make the trip from water to work and back each day. Just as this scheme was about to be put into effect it came near being completely blocked, because 36 water cans could not be gotten. In the early part of June all troops were moved north to El Valle, so this work stopped after it had been gotten sufficiently in hand for it to be evident that the necessary result could be accomplished.

After the road had been graded all the way to south of Dublan, and before there had been any rain to speak of, it had been run over in places by the trucks, but generally they had not gone on it. Where trucks had been on it, it was simply a pile of fine dust. A truck could hardly get out, if it got into this soft material. Most of the road was a pile of loose dirt, and no truck had gone on it. Practically everyone thought the grade would never be used. It appeared that truck trains would never run on it enough to pack it, and it was feared that unpacked it would be very muddy when wet. Finally, the commanding general ordered a train to travel the grade from Dublan to Columbus. This train packed a rut in the soft grade, and another train soon followed in this rut, having been driven off the old trail by mud. After this, rain drove all traffic from the old trail to the grade.

Water soon changed the pile of dust into an elevated strip, which after rains was the first place to be passable. Of course, a dirt grade when wet is cut by traffic, and unless it is quickly worked on will soon be ruined. It became necessary to organize the road gangs into maintenance gangs and surfacing gangs.

The character of the material of the road, of course, varied in different localities and required different treatment. Certain places could be maintained without any metal surface. Others required some kind of a surface. Certain sandy stretches were fairly good when wet, but a few dry days made them almost impassable. When the sand was wet and best, the same rain might have turned the road a few miles away into an impassable mud hole.

Wherever surfacing materials were nearby surfacing was done. In some places gravel was used. In others "Caleche" was the only available surfacing material. It, when wet, makes a very good surface. This surface, however, does not last very well under heavy traffic, so it has to be frequently patched. There was not time to get rock crushers, where rock was available, even if everyone had not believed that the expedition would be withdrawn before a crusher could be installed. There was no hope of surfacing the entire road in time to do any good, so the worst places only were worked on.

The surfacing presented a different problem in each locality. If the haul was too long, and there was water nearby, teams could be used. If the haul was long, trucks or wagons pulled by tractors had to be used. If there was no water close by, it was impossible to camp teams near enough to the work to do any good. Trucks could not be obtained in sufficient quantities, and due to uncertainty of length of stay of the expedition, dump wagons for the tractors to pull were not ordered in sufficient numbers.

The matter of getting something to work with, especially trucks, was simply a matter of the apparent necessity. If the truck trains traveled without much delay, then nothing could be gotten for road work. When two or three trains had got stuck up to the bodies of the trucks in the mud, and things looked as if people might go hungry, then means to work would be provided. Of course, each time this happened the remedy was too late for that particular condition, but it might prevent its recurrence. After some bitter experiences of this kind, the provisions for road work were fairly generous.

Surfacing with teams was limited to the 15 miles north of Dublan. As previously stated, the amount of material carried by a native team was ridiculously small. A sandy stretch about 7 miles long was partially surfaced with Caleche. The first 1 or 2 miles was done fairly quickly, but when the haul got longer the work went very slow. Later trucks were used on the long haul, but not enough tracks could be put on the work to get rapid results. Then a tractor pulling about a dozen dump wagons was used. Before the stretch was completed, the rainy season was over and the work was stopped, and traffic went back to the original trail. No attempt was made to surface any more than a strip 8 ft. wide in the middle.

On the northern part of the road, tractors pulling dump wagons were used almost exclusively, and the worst places were thus surfaced. Work in this section was hard to accomplish, except in certain localities where there was water. In the long stretches when there were no streams and no wells, wells had to be drilled or water had to be hauled to labor camps. Several wells from 500 to 800 ft. deep were drilled.

When the grade was first finished it was planned to establish a maintenance camp every 10 miles. This was not accomplished entirely because wells were not drilled quickly enough. However, for about 25 miles north of Dublan it was feasible and was done. The idea was to put 2 teams with drags at each one of these camps, and to have each team drag 5 miles from camp and back each day or after each truck train had passed. This scheme worked pretty well when it was put into effect.

Where the road surface consisted of adobe it dried out remarkably quickly after a rain, and was left compacted into a very good dirt road. If a truck train did not go on it too quickly after rain, it was not damaged much. The first 8 miles north of Dublan was mostly good during the rainy season by reason of the material and constant dragging. It was a good example of what dragging may accomplish. A truck train was seen to go on this grade within 2 hours after a hard rain, and but slight damage to it. However, such a road must be dragged promptly after it has been rutted, and exactly at the time when the material is of the right constituency to be dragged smooth. After this it will bake hard and smooth with most astonishing rapidity. The dragging must be done with the utmost dispatch and with intelligence.

The drag used on the Dublan section was improvised from logs or 3 by 12's and old wagon tires or scrap iron. A blacksmith shop was found at Corralitos Ranch, which luckily had around it tools and scrap stuff with which drags could be fashioned.

A longer drag was tried first, but it did not work well. The small, native teams had trouble pulling even this short one. Sometimes 4 native mules, sometimes 6 mules, and sometimes 8 mules were hitched to this drag. The trucks generally made 2 ruts in the road. The drag would go down filling in one rut and come back filling in the other. Where it appeared advisable to move any material, a small (6-ft.) grader could be used. It was pulled by 1 or 2 army teams of 4 mules each, or by 2 Jeffery trucks.

By maintenance, such as is described above, viz.: Graveling in places, dragging and regrading, the road was kept in fair condition during the greater part of the rainy season. On one or two occasions, things looked pretty bad. After a hard rain truck trains would be delayed for as much as two or three days, and it would look as if there might be a serious interruption of the supply of the expedition. However, these situations were not very numerous and the rainy season passed without any mishap. The wet season proved to be quite short and not very wet generally. There was no general rainfall, and heavy rains in limited localities gave all the trouble that was experienced. By the middle of September the season was practically over, and the problem developed into a dry weather problem again.

When roads began to get dusty again, the graded road soon began to wear out and to give trouble. Soon traffic went back to the original trail. It had been hardened and made smooth by rain, but it also began to cut up and to develop into chuck holes and dust. About this time Colonel Walker, who had relieved Major Brown in charge of road work, started a scheme of scraping off the top surface of the road (not the grade), and leaving the road a sunken road. This was possible now with the graders and tractors on hand, although it had not been possible in the previous dry season, when the machinery had not been gotten. When the scheme was first started, the idea was to scrape off the soft top surface and leave a firmer, smooth surface for the trucks. It was expected that this surface would soon cut up, and that it would be necessary to keep moving the road, scraping a new place each time the trucks cut up a scraped place. However, it soon developed that the sunken road could be kept in a fair condition by scraping, and that it was unnecessary to make new roads. The lower material appeared to stand the traffic quite well, if it was craped once or twice a week, and this scraping prevented the development of chuck holes, or excessive dust. The reason for the success of this scheme was never completely explained.

Brick Pavement on 3 In. Reinforced Concerte Base

A 3-in. reinforced concrete base is being used in connection with the construction of brick pavement on two streets at Parkersburg, W. Va. A 4-in. vitrified block is being laid, with a 1-in. cement-sand cushion and a cement grout filler.

The subsoil is a sandy loam, some of it approaching the condition of a natural sand bank, with excellent drainage. The reinforcement consists of ⅜-in. steel rods, perpendicular to curb, and spaced 2 ft. center to center. Expansion joints are placed along each curb and transversely at intervals of 200 ft. through the base and brick.

Some of the taxpayers wished to use a sand and gravel base with the brick to reduce the cost. The thin concrete base, therefore, was adopted in order to make the cost of the superior construction as low as practicable. Bids were received on both types, the figures submitted being as follows: Vitrified brick pavement on 6-in. sand and gravel base with sand cushion, $2.00 and $2.10 per square yard; vitrified brick pavement on 3-in. reinforced concrete base, $2.45 and $2.54 per square yard. Wm. M. Hall is City Engineer of Parkersburg, W. Va.

Plans for the manufacture of a third type of army motor truck have been announced by the War Industries Board. The new truck will be of ¾-ton rated capacity and supplementary to a 3-ton and 1½-ton trucks.

Road Material Haulage in Wayne County, Michigan, by Industrial Railway

In its concrete road work the Road Commissioners of Wayne County, Michigan, have made extensive use of the industrial railway. On long hauls this method is employed for transporting all materials from the point of receipt to the point of construction. The outfit consists of one or more 7-ton 30-H.P. locomotives, 60 or more 1,000-lb., double side, V-shaped steel dump cars, each of 1½ yd. capacity, and 8 16-ft. flat cars, all of 2-ft. gage. The track is furnished in built-up units, 15-ft. in length, consisting of steel rails fastened to steel ties. A turnout may be laid wherever needed by replacing a section of track by a switch or curve, as this is also furnished in 15-ft. lengths and of such radius that locomotive and cars will readily pass through.

The average train consists of 30 loaded cars, on a level road, and 9 only where the grade is 6 per cent, though as many as 42 cars have been hauled at one time.

Materials for the work begin to arrive before actual concreting is in progress. These are immediately unloaded by a clamshell bucket and thrown into stock piles. After concreting has been in progress, the materials are unloaded directly from the railroad cars to the steel dump cars and transported to place. The unloading crew consists of four laborers, an engineer, and team and teamster. The team hauls 7 loaded cars to the siding where trains of 30 cars are made up. Whenever shipments are delayed the stock pile is resorted to for materials. Work usually is started at the end farthest away from the railroad switch. Five miles per hour is the average set speed, including time for coaling and watering. The actual running speed en route is from 6 to 8 miles per hour.

Materials are readily measured in the cars and distributed along the road at such intervals as to best meet the requirements of the mixer. The aggregates are loaded into the dump cars, the cement in any available cars, and expansion plates, asphalt filler and other necessities on the flat cars. Coal for the mixer is likewise brought to the site over the railway. As concreting progresses the haul becomes shorter and the track is taken up. These rail sections are transported to the loading point on the return trips of the train.

The railway crew consists of an engineer, a fireman and two or more brakemen.

In the work last year long hauls were of frequent occurrence. On one job the farthest point of haulage was over 9 miles; on another job it was 7 miles.

Paver Lays Brick for 1,111 Sq. Yds. of Pavement in One Day

In the construction of a monolithic brick pavement on the Des Moines-Camp Dodge Road in Polk County, Iowa, one of the pavers in one day laid the brick for 500 ft. of 20-ft. pavement. This figures 1,111 sq. yd. Against a stop watch for a considerable time he placed two bricks per second. With 39 brick to the square yard he handled 43,300 9¾-lb. brick during the day.

The American Association of State Highway Officials is now holding its annual meeting at Richmond, Va. The proceedings opened Dec. 4 and close Dec. 6.

Cold Weather Construction of Concrete Roads

Some useful suggestions on the construction of concrete roads in cold weather are given by Duff A. Abrams, Professor in Charge, Structural Materials Research Laboratory, Lewis Institute, Chicago, in the November issue of the Concrete Highway Magazine, from which we quote the following matter:

Methods to be followed in combating injurious effects of cold weather in concrete road work may be grouped under the following headings:

A. Precautions which at all temperatures are known to be conducive to concrete of high strength. (Sufficient cement; clean, properly graded aggregate; smallest practicable quantity of mixing water; sufficient mixing; proper finishing methods; prevention of early drying out; sufficient protection from traffic.)

B. Application of artificial heat to materials or finished work, and means of preventing the dissipation of heat developed during setting and hardening of the concrete. (Heating of water or aggregates; heating fresh concrete by steam lines; the use of covering, etc.)

C. Use of chemical compounds which will lower freezing point of mixing water, or accelerate the setting and hardening of the cement.

In the case of concrete road work done in cold weather, it is essential that the concrete be given every possible advantage in gaining strength at an early period in order that it may safely resist the destructive action of freezing temperatures. Dirty aggregates, and especially aggregates containing organic impurities, are certain to cause trouble in cold-weather concreting, due to the slow-setting and weak concrete produced by such materials. Too much water causes a great loss in the strength of the concrete, prolongs the time required for hardening and furnishes a surplus of the very element which is responsible for cold-weather troubles.

Special care must be taken to avoid the use of lumps of frozen aggregate. Attention is generally called to this point in specifications. On account of frequent moving of equipment, heating of the aggregates is not always practicable in road work, although this is readily done in other kinds of concrete construction. However, if a road roller or other source of steam supply is available, aggregate piles may be heated by inserting pipes carrying live steam. Such heating will be greatly facilitated by covering the piles with canvas.

Valuable results can be attained at little expense by heating the mixing water. This can best be accomplished by inserting an improvised steam coil in the water line near the mixer. The water coil may be heated by a coal or wood fire. It is not necessary that the water be extremely hot; it will accomplish a useful purpose if this method serves only to remove the chill from the aggregate and impart some heat to the fresh concrete.

When there are indications of the temperature falling below the freezing point during the few hours following the placing of the concrete, it is important that the heat generated by the chemical reactions which accompany the setting and hardening of the concrete be retained. This may be accomplished by placing a covering of canvas or other material over the newly laid road in such a manner as to leave an air space above the concrete. Disturbance of the enclosed air should be prevented as much as possible by weighing the canvas with timbers, sand or earth.

In the event of an extreme drop in temperature, pipe lines supplied with live steam may be carried under the canvas to protect the fresh concrete from freezing. If the concrete is partially hardened, protection may be provided with a covering of straw or manure. Manure should not be placed in direct contact with the road surface on account of possible injurious effects on the fresh concrete and unsightly discolorations which may result.

The comparatively low strength of concrete exposed to cold weather indicates the importance of taking precautions to exclude traffic for a longer period of time from concrete roads finished at low temperatures. In estimating the time during which traffic should be excluded, it is good practice to disregard each day during which the thermometer falls below the freezing point.

Of the chemical compounds which have been used in cold-weather concrete work, calcium chloride and common salt (sodium chloride) probably give the best results. Calcium chloride possesses the property of lowering the freezing point of water and accelerating the setting of cement, as well as causing the generation of a large quantity of heat, due to the chemical reactions which occur. Tests made in this laboratory show that calcium chloride in small quantities does not cause appreciable reduction in the strength of concrete, nor does it cause corrosion of the reinforcing steel. This compound is generally sold in the crystal form. It is readily soluble in water. If used in quantities of about 3 per cent by weight of mixing water it will enable concrete to be placed with the temperature several degrees below freezing with little danger of injury. It can best be added to the mix by making a solution having a concentration of 1½ lb. of calcium chloride per gallon of water. This may be kept in a barrel near the mixer. Add 1 gal. of solution for each sack of cement used. For the usual 1:2:3 mix this corresponds closely to 3 per cent of the total mixing water. The use of this material will add about 3 ct. per square yard to the cost of the concrete.

Common salt is effective in lowering the freezing point of water, but does not compare favorably with calcium chloride in other respects. When used in quantities of about 5 per cent by weight of mixing water it has been found effective in preventing freezing at temperatures not lower than 28° F. Its low cost is its principal advantage. Many of the proprietary "anti-freezing" compounds have common salt as a base, with small percentages of other salts, added apparently for the purpose of disguising their real constitution.

It is the writer's belief that the precautions to be observed in cold-weather road work should be considered in the order mentioned above. Special measures should be adopted only after all ordinary precautions are in effect. Heating of mixing water should not be relied upon to counteract the ill effects of dirty or poorly-graded aggregate, or an over-dose of water in the batch. Generally the heating of concrete materials and protection of fresh concrete will be found most satisfactory. It is not usually desirable to rely solely upon the use of chemical compounds to prevent freezing of concrete. Chemical compounds should be used only in conjunction with other measures described.

Tulsa County, Oklahoma, has voted a $1,750,000 bond issue for the construction of approximately 200 miles of paved highway.

Instructions of Missouri State Highway Department for Making State Road Surveys and Plans

The State Highway Department of Missouri, of which Mr. Alexander W. Graham is State Highway Engineer, has recently issued a bulletin of instructions for making surveys for the construction of state roads. The regulations follow:

Reconnaissance.—The reconnaissance is made for the purpose of determining the feasibility of establishing and improving a road as a "state road," and to show where relocations may be made to advantage. After these questions have been determined from the results of the reconnaissance, the final survey must always be made to allow accurate mapping of the road and a precise determination of the quantities to be paid for in its improvement.

Where the location of the road is known at the start, i. e., when a map is available showing the road, or a description of its location is a matter of record, a very good reconnaissance can be made by using an automobile with a good speedometer to measure distances and a hand level to measure slopes. Speedometer readings should be taken at all culverts, bridges, intersecting roads, railroad crossings, deposits and outcrops of rock, gravel or other road building material, and all other features having a bearing on the proper location and improvement of the road. At all grades over above five per cent the hand level should be brought into play, and a rough profile of the hill taken. Records should be kept of where material from cuts should be deposited in fills, giving the approximate haul and the character of the material to be excavated, whether clay, gravel, loose rock, solid rock, etc. The hand level should also be used in places where the cross-section of the roadway is unusually irregular in shape or where the road is located on a transverse slope. Rough cross-sections will be necessary in case of an irregular surface and on side hill work the transverse slopes should be measured.

At all waterways as complete information as possible should be recorded concerning the sizes of existing openings through bridges and culverts, high water marks, drainage area above the road, general direction and location of the waterway across the road, and for some distance each side.

If the road is to be practically relocated throughout its entire length, the easiest method to follow will be to make a stadia survey to obtain the required elevations, distances and angles. The line should be tied in to existing monuments and land lines wherever possible.

If a transit with stadia wires is not available, a traverse line should be run and a hand level used as indicated in the case of the reconnaissance where the line is previously known. In all cases, the same information as noted above should be recorded.

After making the field survey, a sketch map should be drawn up or traced from an existing map. This will show the road from one end to the other, intersecting roads, streams, railroads, etc. If the territory traversed was sufficiently irregular that levels were taken throughout a rough profile may also be drawn.

Next the reconnaissance estimate of the cost of improving the road should be made. This will include cost of grading, constructing culverts, bridges and wearing surface, and supervision of the work. The cuts and fills should be balanced, and the grading expressed in so many cubic yards of excavation containing a certain percentage of rock. The number of culverts should be given with their total estimated cost. For all structures of more than 20-foot span, a list should be given with the span and type and estimate of cost of each. The surfacing, after the type has been decided upon, should be given in square yards of a certain depth at so much per square yard. The estimate would then take the following form:

RECONNAISSANCE ESTIMATE.

..........................Road Date...................191....
Excavation.......... ....cu. yd. ....per cent rock at
......per cu. yd................ $............
Culverts........... ......No. Total, $............
Structures over 20′ span......No. Total, $............
Surfacing of..... ...sq. yd. ...depth ...per sq. yd $............
Total .... $............
Supervision, etc., 10 per cent.. $............
Grand total .... $............

Final Survey.—If the reconnaissance shows that the road can be constructed to the satisfaction of the State Highway Department, a final survey will be necessary.

In making this survey, it must be borne in mind that it is being made with the purpose of securing the data necessary for making a map, profile and cross-sections of the work to be done.

Survey should consist of the running of the center line, marking the location of the necessary objects along the road, running levels and taking cross-sections, and securing such information on bridges and culverts and the general drainage situation as may be required.

Survey Line.—The final survey line is to be the actual construction center. If preliminary lines are necessary the center line is to be located after plans are drawn. The angle points should, if possible, be located on the nearest one-tenth foot marks and the deflection angle for each course should be measured to the nearest minute and the magnetic bearing of each course must be taken and indicated on the plans. Every angle point should be referenced in with three ties to permanent objects unless the courses are very short. All curves should be run in the field at the time of making location. On resurfacing work it is not necessary to run curves, but angle points should be referenced about every 1,000 ft.

Side Locations.—In general a tape survey will give the necessary accuracy in making locations. All significant objects within a hundred feet or so of the finished road should be indicated, but where they are at a greater distance the dimensions, etc., may be estimated. Whenever the position of an object becomes important (as for instance when a stream nears the road embankment or when a house is situated close to a road whose grade it is planned to change to a marked degree) locations should be made to the nearest foot.

Offsets from the survey line to the bordering fences or walls should be made every 100 ft. or oftener if the irregularities so require; dividing property fences should be located by offsets from the center line, but the direction may be satisfactorily indicated by determining their range intersection with the base line; and when it becomes necessary to locate buildings or other objects accurately it will be sufficient to determine their range on the base line and their rectangular dimensions. Location of materials, quarries, gravel beds, etc., should be taken and it should also be noted where water may be obtained for sprinkling the roads.

Alternative Lines.—In case the engineer is undecided which of two possible relocation lines should be followed, he should run a line from each location. These lines to be designated "Line A" and "Line B." Profiles and cross-sections should be taken along each line and plans of both submitted to the State office with reasons for selection of the route adopted and an estimate of the cost of each also to be furnished.

Alternative lines should be made on separate sheets.

Levels.—Profile levels should be taken at least three hundred feet beyond the beginning and end of the proposed road.

A well-adjusted transit-bubble will be sufficiently accurate for general highway work where a closing error of one-tenth foot per mile will be allowed.

Levels should be run forward and backward along the course of the road in order to close the circuit. Bench marks on some prominent object should be taken at intervals of each one-fourth mile and recorded in the notes.

The profile levels of the center line and bench marks should be run in one operation and check levels run in the same operation with the cross-sections, but do not attempt to do both at one operation.

It is not necessary to run check levels on resurfacing work.

Cross-sections.—Cross-sections should be taken at all one hundred foot stations in regular country and at shorter intervals where the ground undergoes a marked change between stations. Where rock is encountered, sections and soundings to determine the elevation of the rock should be taken at such frequent intervals as the surface requires.

At the station points, readings should be taken on the center line of the traveled way, the right and left edges of the traveled way or of the road way, at the top and base of each slope and one reading farther out (not less than thirty feet from the center line of location) at either side to show the slope of the natural surface.

Readings on the ground should be taken at the nearest one-tenth foot.

In general it will not be necessary to show more of the topography than these cross-sections will reveal. In cases where the location of the road is open for some question, a short topographic survey might be made in order to show on the plans the circumstances which caused the choice of the location to be made.

Take only a few cross-sections to show condition of road on resurfacing work.

Drainage.—Complete provisions must be made for the drainage of every road and the plans must show what arrangements have been made and complete data must be furnished for all drainage structures larger than regular standard culverts. Estimates of the drainage area for all structures must be given in all cases.

For culverts the length, width and average slope per one hundred feet of drainage area should be noted and the direction of flow indicated on plan by an arrow.

Ditches.—Whenever the road is at a grade of less than 0.5 per cent, the grading of the drainage ditches must be planned by a separate grade. The design of the ditch must be shown on the cross-sections, and all grades of less than 0.5 per cent should be avoided if possible.

Underdrains.—The engineer should take special care to note or to determine by local inquiry any parts of the road which break up in wet seasons and specify underdrains.

Culverts.—Small culverts crossing the center line of the road should be of sufficient length to prevent any decrease in the crown of the road where it passes over the culvert.

Every bridge and culvert within the course of the design should be described in the specified form whether it is or is not intended for reconstruction.

At every culvert which it is proposed to construct or reconstruct, a cross-section should be taken along the proposed axis, and the section taken far enough out to show elevation of inlet and the lowest possible outlet available, even if this involves the construction of a short ditch.

Profiles must also be taken on the center line of the road, the elevation of the finished roadway noted, and, if the culvert is to be located on a skew, the angle of the skew must be given. Do not try to build culverts at right angles to the road if same should be built on a skew to fit the stream.

Considerable attention should be paid to the angle at which any drainage structure crosses the road, and if they should be built on a skew, these angles must be noted and the length and type of wings should be noted in every instance. Culverts should not be designed askew if possible to economically change the course of stream.

Plans.—The plans will consist of a title page, typical cross-section of improvement, plan and profile, cross-sections, and such structural plans and state structural standards as may be necessary to properly show the proposed construction.

All plans or drawings will be on flat sheet, 22x36 ins. outside dimensions; boundary lines are to be so placed as to provide a binding margin 2 ins. wide at the lefthand end, and a margin ½ in. wide on the remaining three edges of all plans. On cross-section sheets, the boundary lines may be omitted but sufficient space should be allowed for the 2-in. binding edge at the lefthand end of the sheets. State Highway Department standard sheets showing structural standards may be made a part of the plans and be attached thereto, provided the size of these standard sheets does not exceed the size required for plans.

The plans are to be based upon the surveys described above, and all notation necessary to make the required details clear is to appear appropriately throughout the plans. Any information which the local officials may deem necessary for their own uses may be incorporated in the plans in addition to that herein prescribed, provided it does not interfere with their legibility.

The sheets composing the set of plans shall be bound in the following order: Title page, typical cross-section of improvement, road plans, state standards, special structural plans, and cross-sections.

The plan and profile shall be placed on the same sheet; the plan shall be shown across the top of the sheet and the corresponding profile directly below. When the conditions permit without interference or overlapping, two sections of the plan and profile may be shown on the same sheet.

The plan shall be drafted to a scale of 1 in. equal to 100 ft. or 1 in. equal to 50 ft. in the option of the engineer, and the profile shall be drafted to the same scale horizontally as the plan, and to a scale of 1 in. equal to 10 ft. vertically.

Resurfacing Old Concrete Road with Three Inches of Concrete

In 1916 the Road Commissioners of Wayne County, Michigan, resurfaced an old concrete road with a thin layer of new concrete. The methods employed in this experiment were described in the March 7, 1917, issue of Engineering and Contracting. The work was carried out on Grand River Avenue Road and included the widening of the traffic way by the addition of 2½ ft. of concrete on each side of the old pavement and the covering of the entire 20 ft. of old surface with a slab of concrete 3 in. in thickness.

In order to give a fair presentation of the condition of this experimental work after 15 months of wear the Commissioners invited Mr. Frank F. Rogers, State Highway Commissioner of Michigan, and Mr. H. Eltinge Breed, First Deputy Commissioner New York State Highway Commission, to inspect the road and make a report of their findings. The inspection was made Aug. 28, 1917, and the reports are given in the last annual report of the Commission, from which we quote as follows, the first quotation being from the report of Mr. Rogers:

Grand River Road Resurfacing Experiment After 16 Months of Wear.

> It had always been the writer's opinion that a thin slab of concrete, say less than 5 in. in thickness, laid over an old concrete pavement would simply result in work which would immediately crack into small pieces and then cleave from the underlying pavement, thus making an entirely worthless job within a few months or at most a year or two after completion.
>
> The experiment on Grand River Ave. has demonstrated not only the error of such a conclusion, but that it is entirely feasible and practicable to resurface with concrete not more than 3 in. in thickness, provided the same is properly reinforced and as much care used in the selection of materials as we know to be necessary to produce a satisfactory concrete pavement in the first instance.
>
> On the whole the defects visible on this piece of work are no more numerous than one would naturally expect to find on the same area of a well-laid concrete pavement of the same age, and subject to similar traffic conditions.

Mr. Breed's statement, in part, follows:

> . . . . . From an engineering standpoint, it is, as far as one can tell at present, an unqualified success. What may happen in the future one would be loath to predict, but up to the present time it has endured 15 months of traffic at the rate of over 1,500 vehicles a day, it offers smooth riding qualities, is non-slippery, and shows not a sign of disintegration. The cracks that somewhat mar the appearance of the surface were probably caused by too rapid or by unequal hardening of the rich mixture used. Many of them are hair cracks which would have been unnoticeable had they been let alone. It was, I believe, a mistake in maintenance to pour them with tar, because they were not open enough to absorb the material, which exuded in dark streaks.
>
> It is significant that on either side of the road where it was widened 2½ ft., there are no cracks at all, nor any suggestion of demarcation. This is valuable evidence for engineers who are, or soon will be, confronted by the necessity of broadening our main traveled routes when they are resurfacing them.

Resolution of Ohio Good Roads Federation for Continuation of Highway Construction

At a meeting last month of the trustees of Ohio Good Roads Federation resolutions of interest to the highway building industry were adopted. The resolutions follow:

Whereas, the conditions created by war have made the federal government the largest user of available transportation facilities in addition to those required by agricultural, industrial and commercial demands, and

Whereas, such available transportation facilities are unable to meet the present combined demand of the government and private enterprise upon them; and

Whereas, for reason of these added burdens our present transportation facilities are sure to be the limiting factor in general business, thereby lessening both the earning power of our citizens and their industrial efficiency; and

Whereas, the railways of the country admit their inability to cope with the dual demands upon them and the danger attending such decrease of transportation service, which may bring, not only suffering upon the people, but a possible catastrophe to the nation by reason of its helplessness to transport those things needful for use upon the farm, in the mill, the factory, the store and the home; and

Whereas, the public highway is recognized as an instrumentality of incalculable value to the nation for transportation purposes, and is the one great agency to which we must now turn as the means for exchange of the products of the nations's industry; therefore we

Resolve, that we view with alarm the policy of stopping the improvement of public highways, as a non-essential enterprise, when it is apparent that the public highway is the single unit of our transportation system upon which alone private enterprise of every character may have to depend for its very existence; and we further

Resolve, that instead of curtailing the improvement of highways we earnestly urge their development as primary factors of immediate concern for preserving and safeguarding the present prosperity and stability of the nation in its struggle for the preservation of human liberty; and we further

Resolve, that we commend the National Council of Defense for recognizing the vital relationship of all transportation agencies, their untiring efforts to secure a correlation of usefulness; and a higher degree of efficiency in all transportation problems. To this end we approve of the appointment by it of a committee on highway transportation, believing that a greater degree of development will come out of a more comprehensive knowledge of the whole subject and its interdependence; and we further

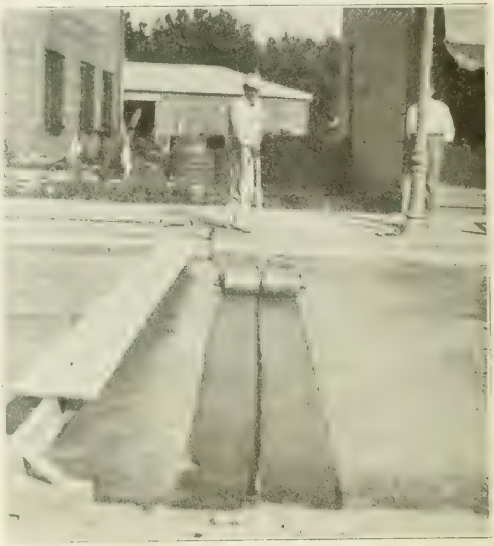
Resolve, that we favor the prompt adoption by the federal government of a general plan for the immediate improvement of those roads of national importance, based upon their commercial or military value, and that we urge Congress to appropriate federal funds for that purpose, to be expended under a permanently constituted Federal Highway Commission, leaving to the states and their sub-units the task of improving those roads of primary state usefulness; and we further

Resolve, that in consideration of the vital importance of road improvement to the nation's welfare we urge that road building material be given a priority classification by federal authorities, so that states and counties may complete unfinished projects; and disconnected sections of roadway serving communities may be joined together, thus making road expenditures both a local and a national asset of inestimable value for preserving the stability of private enterprise and for obtaining a greater mobility of national resources for the presecution of the war. We further

Resolve, that, in view of the inability of the railroads to afford adequate transportation facilities for war and domestic needs, the "Committee on National Affairs" of the Ohio Good Roads Federation be authorized to suggest and aid in formulating a general constructive program of highway improvement, embracing all units of government, which will be wholly essential in preserving the agricultural, commercial and military needs of the nation; and to this end, the Committee on National Affairs is hereby authorized to co-operate with the Highways Transport Committee of the National Council of Defense; and that copies of these resolutions be sent to the members of the Committee on Highway Transportation, of the National Council of Defense, Governor of Ohio, United States Senators, and Congressmen, the State Highway Commissioner, members of the Highway Advisory Board, county officials, county chairmen, officers and members of the Federation.

Split Roller Makes Uniform Blocks on Each Side of Expansion Joint

A split roller for finishing expansion joints in concrete pavements is employed by Mr. M. A. Hahn, a contractor of Gypsum, Kan. The device, which was originated by Mr. Hahn, makes the blocks on each side of the joint uniform. It is made of 16-gage steel sheets, welded together. It is 10-in. in diameter and each roller section is 12 in. in length. The roller has wooden heads. The hub is made of 1¼-in. water pipe, with ¼-in. by ¼-in. strap iron for handle guards. The handle is 1½-in. by 1½-in. yellow pine and is long enough to reach across the slab of pavement. The roller weighs about 40 lb.



Split Roller for Finishing Expansion Joints.

Civil Engineers for U. S. Naval Reserve Force

An examination will be held to select an eligibility list from candidates for enrollment as civil engineers in the U. S. Naval Reserve Force. To compete in this examination it is only necessary for the candidate to send certain information regarding his professional experience, etc., to the examining board. Candidates must be American citizens, and must be an engineer in active practice, or in some business directly connected therewith. To be eligible for the rank of ensign the candidate must be not less than 24 years of age and in active professional practice not less than 2 years. To be eligible for the rank of lieutenant (junior grade) the candidate must be not less than 24 years of age and in active professional practice not less than 5 years. Candidates for lieutenant must be not less than 30 years of age, must have been in active professional practice not less than 7 years and must have had responsible charge of work, as principal or assistant, for at least 3 years.

Methods and Cost of Maintaining Concrete Roads in Wayne County, Michigan

The cost of maintaining the 150-mile concrete road system of Wayne County, Michigan, for the year ending Sept. 30, 1917, averaged $36.50 per mile, according to the last annual report of the County Road Commissioners. The figures covered the cost of tarring and repairing cracks and holes. The maintenance crew is equipped with a tar-kettle, several wire bristle brooms, a wheelbarrow, a couple of shovels, a tar-bucket, and sprinkling cans, and a team. Cracks and spalled joints are swept clean with the wire brooms, after which tar, heated to 225° F., is poured into the clean crack and allowed to stand for a few moments to prevent it from bubbling. Clean, coarse, dry sand is then spread on the tar from a shovel. Any pit holes are given the same kind of a treatment. A slight excess of tar and sand is used, so that traffic will eventually iron out the application. A grade of tar, known under the trade name of Tarvia XC, is used.

If an imperfection that does not extend through the pavement, yet is over 1 in. deep, is to be treated, the cavity is thoroughly cleaned out. It is then dried, painted with hot tar, and filled with stone of suitable size so graded that the bulk of the stone will have voids reduced to the lowest possible point. This filling is then firmly tamped or rolled into place. On top of this patch, hot tar is poured, the quantity being so regulated that it will be enough to fill in voids remaining in the pebbles or stone and leave but a slight excess on the surface. Dry sand is then spread on this excess and traffic irons it down as in the case of similar repairs to joints.

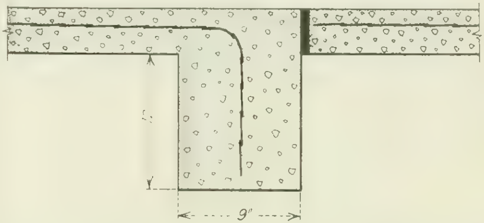
One maintenance crew will do all the necessary work on from 1 to 3½ miles of concrete road surface in a day. Where there is occasion to repair holes that are 2 or more inches deep, they are cleaned out thoroughly, cutting away the concrete so as to give truly vertical sides to the hole. The edges are then painted with a cement grout, and the cavity filled with a concrete mixture proportioned as was that used in the original construction. The repaired portion is protected from traffic until thoroughly hardened, and hardening is accomplished by keeping the repaired spot covered with a moist layer of earth, kept moist by frequent sprinklings for at least 7 days.

Men Wanted for Repair Shops of Army.—Back of the fighting front of the American army in France there will be established warehouses and repair shops for handling vast amounts of ordnance equipment. A division of the Ordnance Department of the U. S. Army, known as the American Ordnance Base Depot in France, will be in charge of this work. Men are needed to enlist in this division, not as fighters, but for overseas service as skilled or unskilled soldier workmen. Men of almost every vocation and trade are needed, particularly automobile repairmen, cooks, gunmakers, harnessmakers, machinists, millwrights, optical instrument repairers, painters, steel polishers, plumbers, etc. The Chicago office for this recruiting is at 435 S. Dearborn St.

It is expected that automobile licenses will furnish the State Highway Department of Pennsylvania with a revenue of $3,500,000 for 1918. All this sum will be expended for maintenance purposes.

Non Creeper Joint for Concrete Pavement on Grades

In some concrete pavements constructed on steep grades a tendency of the slabs to move down hill has been noted. In order to prevent this the New York State Highway Department designed an anchor wall to be put down near the end of the slab. This wall extended about 12 in. below the base of the slab and was reinforced. On one piece of work one of these slabs was put in every 300 ft. The accompanying sketch shows the non-creeper joint as it is employed on one piece of work that is now under contract. It is hoped that this will prevent some of the riding at the joints on the hill sections.



Non-Creeper Joint for 1917 New York State Highway Work.

Cost of Concrete Pavement in Queen Victoria, Niagara Falls Park, Ontario

Several sections of roadway in the Queen Victoria Niagara Falls Park System were paved with concrete during 1916. The accompanying cost data on this work are taken from the last annual report of the Park Commission. The concrete pavements, 18 ft. wide, were laid on a flat subgrade and had a thickness of 8 in. at the crown and 6 in. at the sides. A 1:2:3 mix was used. The unit costs of two jobs were as follows:

	Job No. 1. Per sq. yd. concrete surface.	Job No. 2. Per sq. yd. concrete surface.
Grading	$0.325	$0.230
Drainage	.103	.102
Concrete	1.293	1.512
Curing concrete, etc.	.045	.028
Shoulders	.161	.090
Cement tests	.008	.007
Inspection	.027	.024
Engineering	.054	.044
Incidentals	.111	.070
Totals	$2.127	$2.107

Job No. 1 covers Section 5-A of the Bridgeburg Road. The area of concrete surface is 10,430 sq. yd. The grading involved 1,162 cu. yd. of cut, 2,512 cu. yd. of borrow and 3,274 cu. yd. of fill. A total area of 1,577 sq. yd. of pavement was reinforced with expanded metal at a cost of 19 ct. per square yard.

Job No. 2 covers Section 5-B of the Fort Erie Road, and includes 7,129 sq. yd. of concrete surface. The grading called for 916 cu. yd. of cut and 862 cu. yd. of fill. Some 1,434 sq. yd. of pavement was reinforced with expanded metal at a cost of 19¼ ct.

The rates of wages were: Teams, 45 ct. per hour; laborers, 20 ct. per hour; foremen, 30 ct. per hour.

Plans have been completed for a drainage project near Poplar Bluff, Mo., that involve the construction of 210 miles of ditches and 50 miles of levee. The work includes 8,000,000 cu. yd. of excavation in ditches and 2,500,000 cu. yd. levee embankment. Over 1,114,000 acres of land will be reclaimed at a cost of $1,240,000.

Resurfacing Asphalt Blocks with Sheet Asphalt

A number of asphalt block pavements at Toronto, Ont., which had gotten into such a condition that extensive repairs were necessary, have been resurfaced with a thin layer of sheet asphalt mixture. The tops of the asphalt blocks are burned off with a surface heater and a small amount of old material removed. The surface established is warmer and considerably softer than normal. The new asphalt mixture is immediately placed to a depth of from 1 in. to 1½ in. and rolled to consolidation. The first pavement was treated in this manner in 1916 and during the present year two more pavements have been resurfaced. Last year's work cost 50 ct. per square yard, and this year's work cost 59 ct. and 61 ct. per square yard, respectively.

Tests in Kiln Drying Woods by U. S. Forest Service

The U. S. Forest Service has been making a scientific study of the drying of wood at the Forest Products Laboratory, Madison, Wis., and has developed a method of drying which has been very successful with all the woods tried. Several kilns have been built at the laboratory for experimental purposes and a number of demonstrations made in commercial kilns. Ash and spruce are the woods most in demand for airplane construction, and anticipating the present situation the Forest Service secured a shipment of partially air-seasoned ash and spruce plank for preliminary tests.

This material was kiln dried without injury. Later thoroughly green Sitka spruce, white ash (northern and southern), white oak, Douglas fir, western white pine, and mahogany were secured in the log for testing. The spruce and ash logs were cut up and the green material from each species divided into three matched groups. One group of each species was tested green, another has been set aside to be tested when it has air-dried, and the third group was kiln-dried, trying several methods, and then tested.

Only the results of tests on the spruce have so far been analyzed. Comparison with standard tests which had already been made shows that Sitka spruce can be kiln-dried from the green condition with no more, perhaps less, injury to its mechanical properties than by air seasoning. Definite specifications have been prepared for kiln-drying spruce green from the saw for airplane construction, and, if rigidly enforced, they will insure kiln-dried stock of this species equal to air-dried stock.

Personals

James J. McIlwee, a mining engineer of Denver, Colo., has been commissioned a first lieutenant of engineers at Fort Sheridan, Ill.

James M. Forsythe, an erecting engineer for the Allis-Chalmers Co., has been given a commission as second lieutenant of field artillery.

Burdette Woodward, Parkersburg, W. Va., has been appointed State Inspector of Roads for the State Highway Department of West Virginia.

Hale Judson, formerly assistant city engineer of St. Joseph, Mo., has been appointed city engineer, succeeding Carl P. Hoff, who resigned recently.

W. J. Daly and Henry M. Cohen have organized the Sharon Dismantling & Construction Co. and have opened offices in the Harmony building, Sharon, Pa.

Louis H. Pinkham, Jr., a civil engineer under Frank Spofford, United States Supervisor of Surveys for Idaho, has been commissioned a first lieutenant in the Officers' Reserve Corps at Presidio, Cal.

Charles S. Clark of Donna, Tex., has been appointed a member of the State Board of Water Engineers of Texas to fill the vacancy caused by the resignation of E. B. Gore. Mr. Clark is well known in the lower Rio Grande country as a civil and irrigation engineer. With the appointment of Mr. Clark the State Board of Water Engineers is now complete, the other members being R. J. Windrow of Waco and W. T. Potter of El Paso. Mr. Windrow was recently appointed to fill the vacancy caused by the resignation of J. C. Nagle and Mr. Potter succeeded John Wilson, whose term expired Sept. 1.

P. A. Beatty, Wheeling, W. Va., division engineer for the Baltimore & Ohio R. R., has resigned, and E. C. Wright, Baltimore, district bridge inspector of the Maryland district, has been appointed his successor.

Vincent H. Doyle of Columbus, O., civil engineer in the employ of the Hocking Valley R. R., has been given a first lieutenancy at Fort Benjamin Harrison. He formerly was connected with the Public Utilities Commission.

At the recent convention of the City Managers' Association the following officers were elected: President, Gaylord C. Cummins, Grand Rapids, Mich.; vice-president, C. A. Bingham, Norwood, Mass.; secretary-treasurer, H. G. Otis, Beaufort, S. C.

Carl P. Hoff, who resigned recently as city engineer of St. Joseph, Mo., has accepted a position as assistant to H. M. Stone, resident engineer of the Grand Island R. R., who has charge for the railroad of the work of rebuilding the Grand Island bridge.

The following engineers of the Cuyuna range, Minnesota, have been ordered to report for duty Jan. 5, 1918, in the U. S. Army: C. H. Scheuer, village engineer, Crosby, Minn.; C. M. Pearce, village engineer, Ironton, Minn.; L. T. Gavin, with the American Manganese Company, and S. T. Watson, supervisor of Klondike Township.

Rear Admiral Frederick R. Harris, chief of the Navy Bureau of Yards and Docks, Navy Department, has been appointed to take over the general managership of the Emergency Fleet Corporation, vacated by Rear Admiral W. L. Capps. In 1916 Harris was appointed chief of the Bureau of Yards and Docks at the age of 41. In June, 1917, he received the permanent rank of rear admiral.

At a meeting of the international directors of the Jefferson Highway at Dennison, Tex., on Nov. 23, the following officers were elected: A. W. Hopkins, Lamonia, Ia., president; Thomas H. Johnson, Winnipeg, Man., first vice president; Mrs. John Lamar Kimbell, Shreveport, La., second vice president; Walter Parker, New Orleans, La., secretary; J. E. Combs, St. Joseph, Mo., treasurer.

At the first meeting of the new directors of the Builders' Exchange of Cleveland, O., all of the old officers were re-elected. Sam W. Emerson of the Sam W. Emerson Co. was re-elected president for a second term; C. W. Lundoff, president of the Crowell-Lundoff-Little Co., was re-elected vice president; George Donley of the Donley Bros. Co. was chosen treasurer; Edward A. Roberts was re-elected secretary, and Charles D. Jamieson was again chosen assistant secretary.

H. B. Titcomb, recently appointed superintendent of the Stockton Division of the Southern Pacific Ry., first entered the employ of the company in the capacity of draftsman in July, 1891. He was promoted to assistant engineer, construction division, in 1898, and the year following was named roadmaster of the western division, and was successively roadmaster of the Shasta and Sacramento divisions from 1900 to 1904. He was assistant resident engineer from 1904 to 1905; resident engineer at San Joaquin, 1905 to 1906; and at Los Angeles, 1906 to 1909. From 1909 to 1914 he was district engineer with headquarters in Los Angeles, and from 1914 to Oct. 15, 1917, when he was promoted to superintendent of the Stockton division, he was maintenance-of-way assistant to the assistant chief engineer, San Francisco.

The following men from the office of the State Engineer of New York are now in the Army or Navy: J. M. Angus, J. J. Carroll, W. L. Collins, B. S. Davenport, L. W. Donnelly, J. T. Doris, Roy Engell, R. J. Evers, J. A. Galvin, A. E. Green, J. W. Hano, T. R. Hazelum, H. W. Henderson, E. D. Hendricks, H. F. Hensler, C. E. Heydt, E. L. Horton, P. M. Howe, N. D. Hyde, H. C. Kelly, T. R. Kerslake, Henry Kling, E. J. Moran, J. T. Murphy, J. P. Newton, H. J. O'Neill, E. V. R. Payne, J. M. Prior, F. C. Rogers, G. W. Ruso, J. W. Shook, A. A. Snell, E. A. Terrell, J. R. Tighe, T. J. Torpy, Jr., C. E. Vedder, G. H. Yerkes, S. A. Zierak, E. J. Bulls, J. P. Larsen, G. C. Nash, C. H. Swick, O. L. Burdett, J. B. Doyle, B. I. Hall, Powell Wall, H. E. Dayton, C. T. McLean, E. C. Ruesswig, L. E. Fields, L. R. Spencer and H. S. Deal.

A. D. Williams, State Road Commissioner of West Virginia, has announced the appointments of road supervisors in various districts of West Virginia as follows: Hancock and Brooke Counties, C. E. Grofton; Ohio County, W. O. McCluskey, Jr.; Marshall, Wetzel Tyler and Doodridge, J. R. Wilson; Mongolia, Marion, Harrison, Taylor and Preston; W. S. Downs; Barbour, Lewis, Upshur and Randolph, Charles Swisher; Tucker, Pendleton, Grant, Hardy, Mineral and Hampshire, E. C. Smith; Morgan, Berkeley and Jefferson, E. L. Miller; Gilmer, Braxton, Webster, Clay and Nicholas, George H. Hill; Pocahontas, Greenbrier, Monroe, Summers and the northern part of Fayette, J. K. McGrath; McDowell, Mingo, Logan, Wayne and Lincoln, Blake Taylor; Cabell, Mason and Jackson, W. Stephenson; Putnam, Kanawha and Boone, P. J. Walsh; Roane, Wirt, Wood, Ritchie, Pleasants and Calhoun, W. J. Alexander.

Obituaries

John Dowst, treasurer of Head & Dowst Co., contractors, Manchester, N. H., died Nov. 22, aged 69.

John Jachin Boyd, one of the engineers of the E. I. du Pont de Nemours & Co., died Nov. 22 at his home in Orange, N. J., aged 46. For many years Mr. Boyd had been an engineer and contractor, engaged in installing water supply plants in many cities and for large manufacturing plants.

Charles Van Pelt, an engineer in charge of a section under the chief signal officer of the U. S. Army, died Nov. 23, at Washington, D. C. Mr. Van Pelt was a graduate of the University of Utah and formerly was employed in the engineering department of the Oregon Short Line Railroad.

Waterworks and Hydraulics
Monthly Issue

ENGINEERING AND CONTRACTING

Halbert P. Gillette, *President and Editor.* Lewis S. Louer, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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How an Engineer Induced 12 Towns to Secure a Joint Water Supply

If all civil engineers were as public-spirited and aggressively interested in public affairs as M. M. O'Shaughnessy, there would be fewer blunders made by cities in securing and distributing water. Mr. O'Shaughnessy, city engineer of San Francisco, was formerly a resident of Mill Valley, a district on the north side of San Francisco Bay. He became one of the directors of the Marin Municipal Water District of which Mill Valley is a part, and started a publicity campaign for the development of a water supply adequate for the dozen small towns in the district. After five years of discussion and preliminary work, construction has begun involving an expenditure of $3,000,000. Even the campaign for the bond issue was conducted by engineers. Illustrated lectures were given to convince the tax payers that the whole project was economically sound.

Reclaiming Alkaline Land by Flooding—A Chance for Engineers

There are vast areas of alkaline lands in the west that can be reclaimed by flooding. Many civil engineers may profitably study the commercial possibilities involved in such reclamation.

In our Waterworks and Hydraulic Monthly issue, Nov. 14, we described a successful method of leaching alkali from the soil. The tract was diked into checks and ponded. The water percolated to the underground reservoir, carrying the salts with it. One heavy flooding reduced the alkaline content of the soil from 2.5 per cent to 0.4 per cent for the upper 4 ft. If the soil is not sufficiently porous to allow the leaching water to penetrate rapidly, it becomes necessary to resort to subsoiling or blasting. The essential thing is to cause a fairly large volume of water to penetrate rapidly downward, and not to deposit salts on the surface by evaporation.

Opportunities for Irrigation and Drainage Engineers and Contractors

Most civil engineers have been accustomed to wait for other people to finance land improvement projects. But not a few engineers have already shown the way to others by themselves promoting irrigation and drainage. The Government has passed the Farm Loan Act under which farmers can secure long-time loans at 5 per cent. Farm products are marketable at unprecentedly high prices. These two facts make it clear that civil engineers and contractors can drum up a vast amount of land improvement work, provided they go after it vigorously and intelligently. They must be prepared to show what large profits a farmer can derive from investments in tile drains, pumps and piping systems for irrigation. Irrigation of garden truck is highly profitable in every State of the Union, as we have repeatedly shown. It is one of the functions of the modern engineer, as we conceive engineering, not merely to learn how to accomplish results economically, but to force action from those who will benefit from the application of his knowledge.

Why City Water Rates Should Be Raised

The rates charged by city water departments have rarely been sufficiently high to pay interest on the plant investment and to provide a depreciation fund. This is a fact known to every expert appraiser of waterworks properties, and it is quite generally recognized by waterworks managers also. If rates have been too low in years past, it is patent that they are much too low now. The high prices of materials and labor are increasing current operating expenses, but this is not all. As parts of a waterworks system require renewal in years to come the cost of renewal will be much greater than the original cost. Hence depreciation funds that might have been ample had prices not risen will fall far short of being large enough to provide for renewals at the higher prices that will exist. It would be well if every city were to engage an expert hydraulic engineer to appraise the waterworks and establish rates that would yield, say, 5 per cent net on the value of the plant. As one of our contemporaries recently said, every tub should stand on its own bottom in municipal as well as in other realms of human activity. The profits from city waterworks can well be used to meter the system and for other economic improvements.

Boston Suburbs Have Reduced Daily Water Consumption to 47 Gal. Per Capita: What Does This Mean to You?

For many years American engineers have been accustomed to speak of 100 gal. daily per capita as being a reasonable consumption of water. It may now well be asked whether half this amount is not ample for residential areas in large cities and for the entire area of most small cities where neither irrigation of gardens nor factory requirements are large factors. In 1916 four suburban towns near Boston—Malden, Medford, Melrose and Milton—totaling 108,000 people, averaged only 47 gal. per capita per day. Practically every service in these towns is metered.

Danville, Va., uses only 45 gal. per capita per day now that the water is metered, whereas the daily consumption was 175 gal. per capita prior to metering.

The city of Boston, with a population of 763,000, used 105 gal. daily per capita in 1916, or more than double the rate of consumption in the four suburban towns above named—the four M's. But only slightly more than half the services in Boston were metered. Due to the large use of water for industrial purposes, it is probable that a large city will normally use 50 per cent more water per capita than a residential suburb.

Civil engineers and water works managers who wish to perform a public service should never miss an opportunity to protest in the daily press against the continued waste of water, and to urge metering. Clip such editorials as this one and send it to the editor of your local paper, accompanied with a letter endorsing our editorial opinion. Local engineering societies may very well initiate propaganda that will result in the conservation of fuel, of plant and of water as a result of metering.

Should the Public Pay the Fixed Charges on Idle Plant?

In a short paper on "Expenses and Costs," by H. L. Gant, presented at the annual meeting of the American Society of Mechanical Engineers, the question is raised whether the purchaser of a product should pay a price that includes the prorated fixed charges of idle plant units. Mr. Gant urges the keeping of unit costs in such a manner as to segregate the fixed charges on the plant units during idleness from the fixed charges during actual operation. This serves to concentrate attention on the "expense of idleness" and thus leads to investigations that reduce or eliminate idleness of plant units. Mr. Gant says:

> It seems to the writer that much of the confusion on the subject of costs in the past has been due to a misconception of the subject. The intimate relation between production and costs has not been sufficiently recognized, and the accountant has looked upon costs as a bookkeeping proposition, whereas in truth costs are much more closely connected with engineering production than with bookkeeping and accounting. If the engineer will recognize this fact and insist that money spent without any corresponding production must be kept separate from that which was productive, either directly or indirectly, many of the apparent contradictions with which we are so frequently faced will be eliminated.
>
> As soon as we establish these methods, the following question is immediately put to us by the accountant and financier, "What are we going to do with this expense of idleness?" they having never before realized that it costs something to be idle. My frank answer to that is that I do not know. Moreover, I don't care, provided they do not charge it to me in the products which I buy from them. My recommendation, however, would be that they see how they can eliminate such expense by proper managerial methods.
>
> I am perfectly aware that it is extremely difficult to eliminate all of such expense, but I am also aware of the fact that it is extremely easy to eliminate a large proportion of it. The solution of this problem is one of the economic questions which the war will shortly force to our attention, and I insist that it is primarily a question to be solved by engineers rather than by financiers.

When Mr. Gant recommends segregating the cost of idleness, he is entirely sound, but when he goes so far as to say that he objects to being charged at all for plant idleness, his position is untenable. It is one thing to aim at an ideal economy and quite another thing to penalize all persons who fall short of perfection in production. A "load factor" of 100 per cent—that is, continuous operation of a plant unit to capacity—is an ideal goal, but who has ever attained it?

Both Engineering Investigation and Legislation Needed to Enlist Capital for Water Power Development

Gifford Pinchot, in a letter that appears on another page, advocates legislation that will permit and encourage the development of 50,000,000 H.P. of unused water power. He advocates leases of water power rights for terms not exceeding 50 years, and he also advocates the regulation of power rates by federal or state commissions. If rates for power are regulated by public commissions, we fail to see any reason for limited time leases. The trend of opinion among economists is now in favor of indeterminate franchises for all public utilities that are under state control as to rates charged for service.

Mr. Pinchot is obsessed by the idea that certain power companies are holding "millions of water power out of use to further monopoly." An intimate knowledge of the reasons why many water powers are not being developed leads the editor to believe that Mr. Pinchot is entirely wrong in his suspicions. When public utility companies feel sure that they will be allowed to earn profits that are somewhat comparable with those secured from investments in factories and farms, there will be no difficulty in securing capital to develop every waterpower that is economically worth developing.

Mr. Pinchot speaks of 50,000,000 H.P. of undeveloped water power as if it were all susceptible of economic development now, but the fact is that most of this power can not be economically developed at present, if ever. No one knows what part of it can be developed to compete successfully with steam. Engineering studies of the whole problem are almost as badly needed as legislation that will encourage capital once more to enter the water power field.

Civil Engineers Should Teach and Lead the Public

The time will come when a civil engineer will be considered censurable if he does not persistently bring to public attention his knowledge of ways of saving public money and increasing general efficiency. The public, for the most part, is incapable of solving economic problems. Engineers are trained economists and their function is not merely to solve economic problems, but to see to it that the public takes action along economic lines. For example, it can be demonstrated that it pays to treat city water with liquid chlorine, for the reduced loss of health and life is worth far more to society than the small cost of chlorinating the water. Or, again, it can be demonstrated that it pays to meter city water, for the annual cost of metering is much less than the saving in fuel and fixed charges on the excess plant needed where meters are not used. These are but typical economic facts well known to engineers. Engineers discuss these things among themselves and bewail public blindness to such facts. But who will ever enlighten the public unless engineers do? The time has come for civil engineers individually and collectively to teach the public and to lead it to action.

Who Will Build Barges for the Enlarged Erie Canal?

Early in 1918 the enlarged Erie Canal will be ready to transport barges of 1,000 to 2,500 tons capacity, but early in 1918 there will be no such barges to transport. Indeed, no one seems to be particularly interested in ever building enough barges to utilize this great waterway to a tithe of its capacity. At a cost of $154,000,000, exclusive of interest on the investment during a construction period of 14 years, this 500-mile canal has been built by the State of New York. It can be used to carry 10,000,000 tons of freight annually, provided barges are built for the purpose, but they are not being built. Conceive, if you can, a railway company so poorly managed that its entire roadbed would be finished before ordering the rolling stock. The fact that no company seems inclined to enter the business of operating barges on the Erie Canal is significant. Apparently, no barge company cares to enter into cut-throat competition with other barge companies, to say nothing of competition with the New York Central Ry. This being so, should not the State of New York turn over to a single company the operation of all barges—on the canal, under specified freight rates, that will yield liberal returns on the investment? Should the State not guarantee such a company protection against cut-throat competition with railways? We believe that until these queries are affirmatively answered the great Erie Canal will remain an ecomonic liability.

Thawing Ground for Trench Work and the Cost

To thaw earth that is frozen to a depth of 2 ft. or more is a problem that often confronts a water works superintendent. Edgar S. Smith, superintendent of the Water Department of Pocatello, Idaho, solved the problem in a simple manner and at a cost of less than 10 ct. per foot of trench for thawing.

The ground was frozen 4½ ft. deep and in 24 hrs. was completely thawed to a depth of 2½ ft. The remaining 2 ft. were softened sufficiently to be easily picked. The method of thawing consisted in laying a double line of 1½-in. pipe over the trench and covering it with 6 in. of fine sand. Steam was fed into the pipe from a traction engine boiler, and a block 300 ft. long was thawed at one setting of the engine. It took about 2 hrs. to shift to the next block, haul the sand and cover up the pipe, using 2 men and 2 teams.

The cost of thawing a 300-ft. stretch was 9.2 ct. per foot, as given in detail in our issue of Aug. 8.

The backfill material must either be thawed or manure must be laid over the water pipe before backfilling with frozen earth.

Zinc Balls and a Fire Hose Used to Clean Sewers

An effective method of cleaning sand and silt from pipe sewers has been devised by E. B. Shifley, City Engineer of Owenboro, Ky. A hollow zinc ball is placed in the sewer and a stream of water from a fire hose is turned on. The ball is carried along by the water until an obstruction is met. Then the water is dammed back until its velocity as it escapes around the ball washes the silt away. If a sewer is badly clogged, the first ball sent through must be small—say 5 to 10 in. smaller than the diameter of the pipe. After sending this ball through, a larger one is passed, and so until the last ball sent through is one only 2 in. smaller than the pipe.

Wooden balls were tried with poor results, for, to be most effective, the ball must float and roll along the top of the sewer: Hollow balls made of two thicknesses of No. 24 sheet zinc, with seams at right angles, proved most satisfactory.

In one case 5 cu. yd. of silt were removed from a 600-ft. section of a 15-in. sewer in 4 hrs. The silt was caught in a manhole by a screen back of which was a sandbag.

Causes of Water Waste at Night

Water used between 11 P. M. and 5 A. M. in the residential districts of a city is almost entirely so much water wasted. There are three predominant causes of night waste of water: (1) Open faucets, to prevent freezing; (2) leaky pipes and fixtures, and (3) night irrigation. Night irrigation of lawns and gardens should be prohibited where meters are not used. A water waste survey should be made at regular intervals to detect leaks, even where meters are used.

The open faucet is a necessity only where service pipes and the plumbing in the building are improperly designed or placed. The water pipes in a building should be well lagged with a heat insulator wherever such pipes are in or near an outside wall or in a cellar. Yet this simple economic precaution is rarely taken because building codes do not specify it. It seems to us that waterworks engineers and superintendents should take steps to bring about such additions to building codes as will reduce the necessity of wasting vast quantities of water every winter to keep pipes from freezing.

Predicting Runoff by Snow Measurements

By sending surveying parties over a drainage basin in the spring, measurements of snow depth can be taken and the snow density can be determined. From these data the quantity of water on the drainage area can be estimated. Then by applying runoff coefficients the flood stages of streams can be predicted for given weather conditions. In sampling the snow for density, a brass tube may be used. A cubic foot of snow may yield 0.2 to 0.75 cu. ft. of water. The engineers of the Southern California Edison Co. make such a snow survey every spring.

Engineers as City Managers

At the fourth annual meeting of the City Managers' Association there were 25 managers present and about 90 per cent of these were civil engineers. This is prophetic, we believe, of the coming preponderance of engineers in the management of municipal affairs.

In a report on city management as a profession, Mr. H. M. Waite, of Dayton, Ohio, said in cities of more than 200,000 population executive ability is the prime essential of a manager, whereas in cities of 20,000 or less it is essential that considerable engineering experience be associated with executive ability in the city manager.

It is our opinion that even the largest cities are in need of managers whose engineering experience has been broad; for upon the manager falls the task of selecting engineering assistants, and without engineering knowledge a manager is less apt to make wise selection.

Removing Lead from Pipe Joints

The uses of a compressed air hammer are numerous, and among them is the removal of lead from pipe joints. The chisel used for such a purpose should have a cutting edge about two-thirds as wide as the thickness of lead in the pipe joint, and the cutting end of the chisel should be curved so as to form a sort of hook that will reach into the joint and pare off a shaving of lead ¼ to ½ in. thick. On large pipe (16 in. and up) an air chisel is more economic than an oxyacetylene torch, for the lead melted by the torch is apt to harden again before it flows out of the joint. Of course, if the pipe is cut off at intervals and several lengths are raised together out of the trench, the torch method can be more effectively applied than where the pipe is unjointed in the trench.

Water Power Development

To the Editor: The great war in which our nation is engaged will be won not alone by food and men, but by mechanical power as well. Without mechanical power we could not make or move the weapons with which we fight—guns, ammunition, ships, and supplies. Our national resources of power, whether from coal, oil or water power, are national war necessities. We need them to win the war.

In this gigantic struggle our security requires us to use all these great resources, and to use them wisely and well. The people of the United States own some 50,000,000 undeveloped water horsepower, or about enough to run every train, trolley, factory, mill, mine and electric power plant we have.

For 10 years the friends of conservation have urged the development of public water powers in the public interest. But development has been held back by a little group of water-power magnates and their friends in Congress who have blocked all legislation which would not give them these valuable properties forever and for nothing.

Today, when the nation needs all its resources, the same men who have been blocking reasonable water-power legislation own and are holding millions of water horsepower undeveloped and out of use while clamoring for more.

The time has come when such obstruction threatens the nation's safety and success. We need the development of these powers in war even more than in peace. At the coming session of Congress sound water-power legislation should be enacted as a war measure, based upon principles fair to all sides. These principles I believe to be briefly as follows:

(1) The thing to do with water power is to develop it. Whatever retards or restricts the development of public water powers on terms fair to the public is against public policy and hostile to the general welfare.

(2) Water power belongs to the people. The sites where it is produced should always be held in public hands, for only so can effective control in the general interest be secured.

(3) Where public development is not desired, the right to use water power sites should be leased for periods long enough to permit sound, attractive, and profitable investment, but never longer than 50 years. At the end of each lease all rights should return to the people who gave them.

(4) In order to protect the consumer against extortion, rates and service should be regulated by Federal authority when State or local authorities fail to do so.

(5) Reasonably prompt and complete development and continuous operation, subject to market conditions, should be required. Already millions of water horsepower are held out of use to further monopoly by private corporations.

(6) Corporations or individuals who make money out of rights granted by the people should share their profits with the people.

(7) The public has a right to complete information about every business based on the use of public property.

These are the prinicples for which the friends of conservation have been contending. Many water power men believe them to be fair and sound. They will, I hope, commend themselves to you as wise and reasonable.

This is no time to give away public assets necessary for the welfare of our people both in the war and after the war; and we should no longer tolerate the selfishness of private interests which take the dog-in-the-manger position that they must have these water powers on their own terms, or no one shall use them at all.

As the president has said: "The supreme test of the nation has come. We must all speak, act, and serve together. Gifford Pinchot.

Milford, Pike County, Pa.

Construction Features of Water Supply System and Sewerage Works for the Camp Custer Cantonment

General Data.

Camp Custer, the cantonment for the Michigan-Wisconsin division of the National Army, is located 4½ miles west of Battle Creek, Mich. The site was selected after an examination of 17 locations by a committee of army engineers. In accordance with the well-developed program of the Cantonment Division and the committee of the Council of National Defense in Washington, the necessary organizations for the construction of the camp were headed toward Battle Creek on June 13. Major E. B. Morden, Q. M. C. U. S. A., was selected as constructing quartermaster in complete charge of the entire construction work. His supervising engineer was Mr. J. L. Lee. Porter Bros. of Seattle and Detroit were the general contractors. Samuel A. Greeley (of Pearse & Greeley, Chicago, Ill.), was consulting engineer for the water supply and sewerage work. These men met together in Battle Creek between June 13 and 22, during which interval all work was started in preparation for permanent construction.

The camp is located on rolling upland, of sandy glacial drift. A line of hills 50 to 100 ft. above the building site extends along the northerly portion of the reservation, affording some protection against north winds. The camp buildings extend in the shape of a bow along the foot of these hills for a distance of about 3½ miles on an axial line. The northern part of the building site is occupied by the stables, warehouses and other utilities. South of them is a concrete highway and railroad extending the entire length of the camp. Just south of the concrete highway and extending to the gravel road, about 700 ft. to the south, are the barracks and lavatories for the troops and south of the gravel road are the officers' quarters. The layout follows closely the typical plans of the Cantonment Division. South of the camp the ground is comparatively flat and forms an excellent drill field, while still further to the south the reservation extends about 3.5 miles to provide a rifle range. The freight yards and main distributing buildings for supplies are located near the center of population to the north of the concrete road. Beyond the low hills on the north side of the camp is the Kalamazoo River. The soil throughout is glacial drift, 50 to 100 ft. thick, consisting of sand, gravel and boulders which afford excellent surface drainage. The maintenance of latrines during the construction period was thus greatly facilitated and first class sanitary conditions were maintained throughout.

The Michigan Central R. R. and the Michigan Electric Ry. have main line tracks along the Kalamazoo River just to the north of the camp. These both connect with the Grand Trunk R. R. at a switch track in Battle Creek about 3 miles to the east of the camp. The main railroad line to the camp was built from this switch, affording connections to all three railroads. A special spur of the electric railroad was built into the center of the camp.

The site as a whole is picturesquely wooded and with the rolling surface forms an attractive location.

Water Supply.

One of the most important preliminary steps in connection with the construction of the camp was the selection of the water supply. The first investigation was made on June 13, by Mr. Greeley, and during the next few days much valuable assistance was given by Mr. Rich, State Sanitary Engineer, and Mr. Smith, State Geologist. Four principal sources were investigated as follows:

(a) A filtered water supply from the Kalamazoo River.

(b) A supply from the Battle Creek city water supply.

(c) A supply developed from small lakes adjacent to the camp.

(d) Well water from the Marshall sandstone.

The Kalamazoo River affords an ample supply of water. However, it receives the entire sewage of the city of Battle Creek, with a population of about 30,000, and could not have been used without filtration. Owing to the cost and time of construction this supply was not considered available. To bring water from Battle Creek would have required a force main about 6 miles long. It also would have required an enlargement of the Battle Creek pumping stations or the use of water from Goguac Lake, which was not considered safe without filtration. The surface water supplies from lakes in the vicinity of the camp could have been developed with a minimum yield barely sufficient to cover the camp requirements. The supplies would have called for a thorough control and policing of the watersheds and would have been more vulnerable to poisoning by enemy agents. It was found after careful investigation of local wells and a study of the geology that a sufficient supply of water could be secured from the Marshall sandstone if a sufficient depth of the formation could be located near the camp. For these reasons all efforts were bent towards developing a water supply from this source. The available maps in the office of the State Geologist indicated the southerly limits of the sandstone to be quite close to the reservation and it was therefore necessary to put down test wells to locate the sandstone. These were first started on June 20th and were put down along the south side of the Kalamazoo River adjacent to the building site of the camp. No sandstone was discovered within 80 to 90 ft. Test wells were then sunk on the north side of the river, the first of which developed a sandstone formation 50 ft. thick and yielding 600,000 gal. of water per day from a 6-in. well. Although this location necessitated

Start of Drilling Work for Well System.

the construction of a comparatively long main across the bottom lands of the Kalamazoo River, a permanent location was fixed and construction started on final lines.

On the basis of the recorded yield of wells from the Marshall sandstone in the vicinity of Battle Creek and the records of the test wells, it was decided to drill 8 wells, each 10 in. in diameter, and each to have an estimated minimum yield of 500,000 gal. per 24 hours. These were placed 200 ft. apart in a line 1,400 ft. long. The drilling of wells was started on July 9th with three "Keystone" drilling machines and the wells were practically complete on Sept. 5th, the average rate of progress per machine per day being 18 ft. A 10-in. steel well casing fitted at the bottom with a steel driving shoe was driven through about 60 ft. of glacial drift and 8 to 10 ft. into the sandstone, thus sealing the rock from the overlying sand. A 10-in. hole was then drilled through the rock which was about 50 ft. thick. The wells varied in total depth from 110 to 120 ft.

Lowering 90 Ft. of Universal Pipe for River Crossing.

The water level in the wells was found to be at elevation 798 (U. S. G. S. datum). It was determined that if the pumps were set at elevation 806 they would be safely above high water in the Kalamazoo River. The tops of the well casings were then cut off at elevation 805 to provide drainage from the pumps back to the wells. An 8-in. wrought iron drop pipe 40 ft. long was hung in each well and connected to 10-in. cast iron laterals extending from each well to the main suction lines to the pumps. The maximum length of suction line was thus about 900 ft. made up of cast iron bell and spigot and Universal joint pipe from 10 ins. to 20 ins. in diameter. Each well lateral is controlled by a valve set adjacent to the main suction header. Furthermore the wells are split into groups of four so that either group can be operated independently of the other, the pumps being located at the middle.

It was originally intended to lift the water from the wells into a reservoir by air lift and to pump the water from this reservoir to the camp. After conference in Washington, however, it was found that the air lift equipment could be used elsewhere and as the static lift from the water in the wells to the pumps was not excessive, a vacuum system was adopted. The main suction lines from the wells terminate in the pumping station in two 12-ft. lengths of 20-in. cast iron pipe set vertically. These have tapped into the top, 2-in. galvanized iron pipe connected to vacuum pumps. Two vacuum pumps, built by the American Steam Pump & Compressor Co. of Battle Creek, are provided, each with a capacity of 50 cu. ft. of free air per minute. Gage glasses are tapped into the side of the vertical pipes. The vacuum pumps maintain a sufficient vacuum so that water rises and stands in the riser pipes several feet above the pumps. It has been found in operation that the suction lift amounts to about 15 ft. and that it is necessary to operate the vacuum pumps about 6 per cent of the time. The suction lines have so far been substantially air tight.

The pipe from the wells to the pumps was built in trenches from 6 to 15 ft. deep. These were permanently sheeted and the pipe covered with 2 ft. of hay and 1 ft. of earth. This method of backfilling was adopted in order to make the pipes more quickly accessible in case of air leakage. The main pumping station at the wells is designed for pumping at a constant rate into the storage tanks. Three motor-driven centrifugal pumping units, built by the Advance Pump & Compressor Co. of Battle Creek, are provided, each with a capacity of 1,000,000 gal. per 24 hours. The pumping station is built of wood with substantial diagonal bracing and large doors. Fire protection is afforded by 2 hydrants and a set of Pyrene tanks.

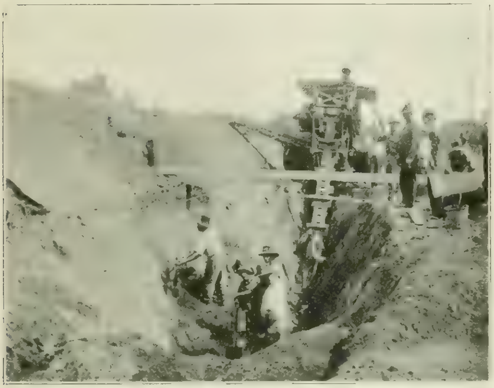
From the pumping station the force main extends about 3,900 ft. to the storage tanks built on the highest portion of the hills just to the north of the building site. From the pumping station to the river this pipe is made up of 12-in. Universal pipe selected to facilitate construction through wet swampy ground.

The construction of the two pipe lines across the river was interesting. First a pile highway bridge was built, on the down-stream side of which a platform was set just above the water. On this Universal pipe was laid for the entire width of the river, and loosely bolted together. This pipe was then hung on 8 chain falls supported from the floor of the bridge above. In this way a length of 90 ft. of pipe was lowered at once into a shallow trench in the bottom of the river. A hoisting engine on the shore provided a means of moving the pipe into place longitudinally. A second pipe line, laid about 8 ft. away from the bridge down stream, was of Class B, cast iron bell and spigot pipe laid with lead wool joints driven up by diver. The connections at the shore ends were made in cofferdams. From the south side

A-Frame Used for Setting Sewer Grades.

of the river to the storage tanks, the force main of 12-in. wood-stave pipe consists of 2 lines across the bottom lands and 1 line on high dry ground. The double line on wet ground was considered advisable because of the difficulty of making repairs.

There are four storage tanks, each having a capacity of 200,000 gal., making a total of 800,000 gal., equivalent to about 10 hours' supply. Two were built by the Redwood Mfg. Co. and two by the Kalamazoo Tank & Silo Co. The piping of these tanks comprises a main line between the tanks with two connections into each tank providing an inlet and an outlet so that the water can be maintained in positive circulation through any one or all of the four tanks. The water level in the tanks is about 100 ft. above the average ground level at the building site.



Sewer Trenching: Deep Cut in Sandy Soil.

In order to increase the pressure of the water at the camp particularly during fires, a booster pumping station was built just below the storage tanks. This station includes 7 motor driven centrifugal pump units, two with capacities of 450,000 gal. per 24 hours and five with capacities of 1,000,000 gal. per 24 hours. These pumps, built by the Union Steam Pump Co. of Battle Creek, together afford a capacity for fire protection at the rate of 6,000,000 gal. per 24 hours, and by the proper operation of units make it possible to adjust the pumping to the varying demands throughout the 24 hours.

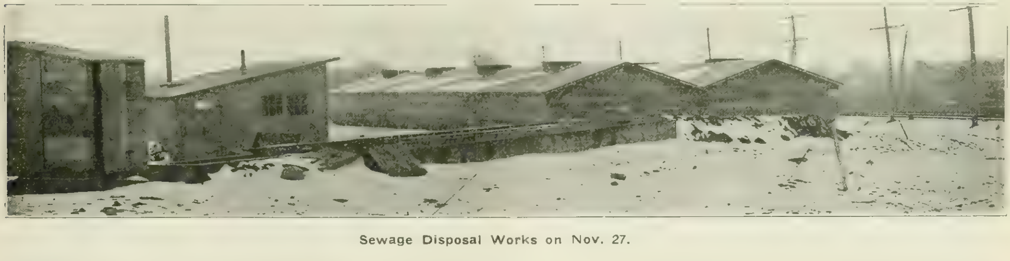
The water from the booster pumping station passes through a Venturi meter built by the Simplex Meter Co. of Philadelphia. A recording apparatus in the pumping station indicates and records the total amount of water consumed and the rate of consumption at any instant. From these records, therefore, the total water consumption and maximum and minimum rates of consumption can be determined.

The distribution system is built almost entirely of wood-stave pipe furnished by the Michigan Pipe Co. of Bay City, Mich. The average rate of pipe laying was 730 ft. per gang per day with a maximum of 1,500 ft. The trenching for the pipes was done entirely by 8 Austin trenching machines. The service lines from the mains to the buildings are of galvanized wrought iron connected to the wood mains by corporation cocks screwed into the wood between the bands. In making connections between the wood pipe and cast iron fittings or valves, the bells on the iron side were machined to exactly take the spigot end of the wood line when driven up tight. There were 15.5 miles of main lines from 6 to 12 in. in diameter and 5.0 miles of service pipe.

One of the interesting features of operation has been the water consumption. The original plans were designed for an average consumption at the rate of 55 gal. per capita as determined by the Cantonment Division. Camp Custer was built for 35,000 men, requiring an average water supply of approximately 2,000,000 gal. per day. With 28,000 present at the camp, the average consumption per capita was 63 gal. and the night flow from midnight to 4 a. m. was at the rate of 32 gal. per capita per day. It is evident that with the full quota of men the average per capita consumption will not greatly exceed the Washington estimate as the total night flow should remain constant and should drop off to about 25 gal. per capita with the larger number of men at the camp. The maximum use of water occurs between 6 and 7 in the morning, and amounts to from 3,500,000 to 5,000,000 gal. per 24 hours. This high rate of use undoubtedly results from the lavatories which consist of showers and running taps with no bowls or bath tubs, so that a high use of water at this time is to be expected.

Sewerage Works.

There was obviously only one outlet for sewage and that was to the Kalamazoo River. As the camp was finally located two points of discharge were available, one near each end of the camp. The rolling topography and the comparatively slight difference in elevation between the two ends of the building site made the location of sewers in shallow cuts rather difficult. At the south end of the camp the topography was so rough that it was necessary to build a small sewage pumping station to serve the first two regiments of infantry. With this assistance, careful location and the use of minimum grades, resulted in a maximum cut of 11 ft. The depth of cut was particularly important as affecting the cost and rate of construction because of the character of the soil. Without sheeting it was found that ordinary trenches would not stand for any length of time at a greater depth than 4 to 5 ft. After an attempt at sheeting, it was found advisable to slope the banks of the



Sewage Disposal Works on Nov. 27.

trench at $\frac{1}{3}$ horizontal to 1 vertical, and to put the additional work of excavation on the Austin trenching machines. With these adjustments, the laying of sewers was maintained very close to the machine and re-excavation owing to slides avoided. Under this arrangement an average progress of 350 ft. per day per machine was maintained throughout the work with a maximum of 1,500 ft. In very deep cuts some sheeting was used.

The back filling was done entirely by machine, 18 Double Quick back fillers made by the Waterloo Cement Machinery Corp. being used for this work.

With pipe laying so close to the trenching machine it was not found feasible at all times to set sewer grades with batter boards. Therefore an A-frame was devised. Two stakes were driven at distances of 4 and 8 ft. from the center line of the pipe. The tops of the stakes were level and at a fixed distance above the sewer. The A-frame was built with a 4-ft. overhang so that the pipe could be centered with a plumb bob and the grade determined with a measuring rod. Sets of stakes were set at intervals of 4 to 8 ft. as required. The sewer pipe sizes ranged from 4 in. to 30 in. Four inch pipe with a minimum grade of 1.2 per cent were used in a few instances for house connections.

The sewage pumping station is built of a concrete sub-structure and a wooden super-structure. The sub-structure is divided to form a storage well of about 4,000 gal. capacity. The sewage passes through screens set with 1 in. clear openings. Three vertical motor driven centrifugal pumps furnished by Yeomans Bros., of Chicago, are set in the dry well and are operated by floats. Normally the pump farthest from the inlet end is operated in order to maintain circulation through the storage well. The pumps lift the sewage about 18 ft. through a 12-in. wood-stave force main approximately 1,800 ft. long which discharges into the east outfall sewer.

The available outlets to the Kalamazoo River following depressions through the hills to the north of the building site naturally divided the sewer system into two districts. The east district serves the infantry and wagon trains with a population estimated at 29,000. The west district serves the artillery and base hospital with a population amounting to about 6,000.

The matter of sewage treatment before discharge into the Kalamazoo River was given careful consideration. The Kalamazoo River is already polluted with the sewage of Battle Creek, Kalamazoo and other towns aggregating over 100,000 population. Although the river was nowhere used as a source of water supply, the State Board of Health was in the midst of negotiations for the installation of sewage treatment plants at the towns discharging sewage into the river. Under these circumstances it was not felt desirable to discharge crude sewage into the river and consequently horizontal flow, hopper bottom settling tanks were built for each of the two sewage districts.

These tanks follow closely the typical designs developed by the Cantonment Division. Some modifications, however, were made. In the first place, the height of the building over the settling tanks was increased about 3 ft. and a walkway was built the entire length of the tanks to facilitate inspection and operation. The grit chamber was not built in the settling tank proper, but was built as a separate unit outside. This was done in order to facilitate cleaning and inspection and also to make form work during construction easier. Finally the baffles were adjusted somewhat differently from the typical designs. Each settling tank is planned with a displacement period of 5 hours, based on an average sewage flow of 55 gal. per capita of tributary population. Measuring weirs were installed at each plant to determine the flow and facilitate operation.

General Progress Notes.

The following quantities of materials were used in the construction of the camp:

Item.	Quantity.	Carloads.
Lumber	46,512,000 ft. B. M.	1,913
Nails	11,884 kegs	19
Roofing felt	......	22
Wall board	3,600,000 sq. ft.	41
Windows and doors	77,846	82
Cement	22,503 bbl.	174
Brick	1,933,300	966
Sewers	32.7 miles	206
Wood water pipe	15.5 miles	

The total number of cars of material was 4,100. The actual construction period was approximately 120 days, so that an average of 34 carloads of material was handled per day.

The first inspection of the camp site by the construction force was made on June 13th, and a preliminary report on water supply and sewerage sent to Washington on June 18th. Test wells were driven on June 20th, and a conference in Washington was held on June 30th. Water supply plans were started July 5th, and materials ordered for the water supply on July 14th. The plans for the water supply were completed on July 21st. Building work was started July 5th. Drilling of wells started July 9th and water was delivered to the camp in the distribution system Sept. 9th. The first sewer was laid on July 24th and the main sewers were in use on Sept. 10.

This record of construction is considered to be unusually good, as was the progress at all of the cantonments, and a number of elements combined to make this result possible. In the first place the general organization and program determined in Washington by the Cantonment Division and Council of National Defense were good and their typical plans and instructions combined great detail with marked flexibility so that the structures could be readily adapted to varying local conditions. The distribution and furnishing of materials were very helpful. The form of contract adopted and the selection of the general contractors were of particular importance in assuring the rapid completion of the work. Finally the selection of the Construction Quartermaster in direct charge of the whole undertaking was, of course, of controlling importance. The energy and harmony with which these various elements worked together toward the completion of the camp was notable.

Saving Freight Cars by Good Loading.—On 77 of the principal railroads of the United States, a saving of 114,109 cars was effected in one month this year solely by increasing the average loading of "less than carload" freight. The reports on which these figures are based—the latest have been compiled—cover the months of July this year and July, 1916. They show that the average loading for that class of freight during July this year was 13,927 lb., as compared with an average of 11,619 lb. during the same month last year. The 77 railroads from which reports have been received were able to move the total volume of less than carload freight last July in 579,180 cars. Had the average loading per car been at the same rate as during July, 1916, they would have been compelled to use 693,289 cars.

The Effect of the War on the Production of Garbage and Methods of Disposal

Studies have been made by the United States Food Administration to determine the effect of the war on the production of garbage and methods of disposal. The results of this investigation were outlined by Mr. I. S. Osborn of the Division of Garbage Utilization in a paper presented at the recent meeting of the American Public Health Association, from which the matter in this article is taken.

The effects of the war on the production of garbage and disposal methods are evident from following sources: 1. The decrease in the quantity produced per capita. 2. The decrease in quality or values recoverable by present day practice. 3. The tendency to change methods of disposal whereby garbage will be utilized.

The decrease in quantity of garbage has been largely due to the increased price of foodstuffs, and the conservation movement which has been started by the United States Food Administration to eliminate food wastes. Up to the present time the increased prices have no doubt had more effect in reducing the quantity than the conservation movement.

A reduction in the quantity of garbage is found in nearly every city, although there are few cases where the quantities have increased this year over previous years. From the studies made by the United States Food Administration, it was found that the results from approximately 60 cities, which reported on the amount of garbage collected, that there was an average decrease of from 12 to 15 per cent, although in some cities an increase is shown over previous years.

The reports show in many cases an excessive decrease, which on an examination of local conditions it is found that less attention has been given to collection, and in many cases garbage has been collected by private collectors for feeding or rendering. On account of the high values of pork, as well as the by-products that can be recovered by reduction, private collectors are more numerous than in former years. No doubt the decrease would have been considerably greater except for the large amount of vegetable wastes going into the garbage pail from home gardens, which were the result of agitation the forepart of the year.

The decrease in the quantity of garbage may not necessarily show a saving made as regards the elimination of food wastes. The amount of grease recovered from the garbage, however, is a better indicator than the quantity of garbage collected.

While the quantity of garbage may not continue to decrease, as this factor is regulated largely by seasonal crops which vary from year to year, or the increased amount of fresh vegetables from home gardens, or an exceptional amount of home canning or preserving, there can be little doubt that the quantity of grease to be recovered from a ton of garbage will continue downward while the present conditions as to foods continue.

The meats are the chief source of grease in garbage. From the data collected during the past 9 months, where recoveries of grease from garbage are made, it shows a decrease of 30 per cent in the amount recovered over the same period during the year 1916; but the actual percentage of grease per ton of garbage shows a reduction of approximately 15 per cent. No doubt there has been a greater reduction in the consumption of meats than was indicated by the decrease in the amount of grease recoverable from garbage. This is evidenced today in the purchase of meat at practically every market, where the scraps, gristle, rind, bone, in fact all wastes which were originally trimmed off and sold to rendering companies, are now in the majority of cases pushed off on the purchaser at the price of the edible meat purchased, so that in proportion to the amount of meat that is now purchased, a greater waste is found by the purchaser than formerly. The chief evidence of this is found in the reduced amount of scraps that were formerly purchased by rendering companies, and the shortage of this material in proportion to the total amount of meats sold at the present time.

One of the noticeable features, as regards the change in garbage, is the fact that the greatest change as to quantity and quality is found in what is known as the middle class. This is no doubt due to the fact that the wealthier class have not changed their mode of living on account of the high cost of foods and are able to afford the same at the increased cost. The poorer section, made up principally of laborers, have been in a position to purchase food at the higher prices, on account of the high prices paid for labor and the increased money available.

The middle class, however, have not had a corresponding increase in income comparable with the increased cost of foods.

The decrease in garbage produced will no doubt continue, not only during the period of the war, but several years following, due to the habits that are formed by the people in the preparing or conserving of food, and in the majority of cases there will of necessity be a readjustment of conditions insofar as disposal work is concerned. The disposal of garbage from necessity will change to meet the future conditions.

The methods for the disposal of garbage at the present time can be classified as follows: 1. Burial. 2. Dumping. 3. Incineration. 4. Feeding. 5. Reduction.

The first two, burial and dumping, are carried on at a low cost, but the only result obtained is the getting rid of the material. The values are lost, and unless proper attention is given they are liable to create a nuisance.

Until recently, there has been a strong tendency towards incineration, especially among the smaller cities. This method, in nearly every case, has been carried on at a considerable expense to the municipality, both for installation as well as operation, with no returns from any source, except in very few cases, where power has been developed, but in the most instances the cost of development has been greater than the revenue obtained.

There is a strong tendency at the present time towards the adoption of other methods of disposal instead of incineration, whereby valuable returns may be made from garbage which would be destroyed. Cities contemplating the installation of incinerators have adopted methods for utilization, and in some cases where incineration plants have been in service for a number of years there is a movement to abandon this practice and adopt methods whereby garbage will be utilized.

Realizing the shortage of materials such as garbage contains, the method of destruction from standpoint of conservation is wrong, although from a sanitary standpoint this method of disposal can be considered one of the most desirable.

Disposal by feeding, or the adoption of piggeries for the disposal of garbage, is a method that will be found desirable in a large number of cities, although in the larger cities no doubt other methods more suitable can be adopted. It is being demonstrated that where proper care is given to this method of disposal very satisfactory results are obtained, and no doubt with more attention given to this method greater advance will be made.

To the average mind the feeding of garbage to hogs is very objectionable, but when ordinary precautions are taken with regard to cleanliness the feeding can be done in a wholly unobjectionable manner, and when conducted properly in a businesslike manner there can be little objection to this method of disposal.

When we realize that from each 1,000 population there is produced waste from the preparation of food sufficient to main 25 hogs and develop them to a point ready for the market, it is evident that by this method of disposal one of the greatest economies can be obtained when properly conducted.

With the present price of pork garbage, when disposed of by feeding, will produce from $7 to $8 in value for each ton.

It is evident from the values that can be obtained from this source that in the smaller cities and communities where garbage can be properly collected and controlled, that no other method of disposal will show the same returns from an economic standpoint as the feeding to pigs, and no doubt there will be a great tendency towards the adoption of this method under the present prevailing conditions, as well as the future conditions which are expected.

The method of disposal whereby garbage is reduced and the valuable by-products are recovered in the form of grease and fertilizer tankage no doubt will continue to dispose of the garbage produced from the larger cities and prove to be the most advantageous method that can be adopted under proper conditions. The decrease in the quantity of garbage, as well as the values that can be recovered, will influence to a large extent this method of disposal. There will no doubt, however, be sufficient wastes in the larger communities having sufficient values to warrant the adoption of this method.

The decrease in quantities of by-products to be recovered will to a large extent be offset by the increased values of the by-products, and at the same time there will be a tendency to recover additional by-products not now attempted. There are developments under way at the present time, and equipment being installed whereby additional recoveries besides tankage and grease will be made.

From present indications garbage will be more valuable for the recovery of by-products than when the grease and tankage were obtained in larger quantities. There is an ever-increasing demand for the tankage produced from garbage for use in the manufacture of fertilizer. A large amount of animal tankage formerly used for fertilizer has been deflected into other sources, so that at the present time there is a great shortage of this material.

There has been objection to garbage tankage as a fertilizer. The price of nitrogenous fertilizer is determined by the available nitrogen. By the old methods of determining the available nitrogen of garbage tankage it was found to be low, but from the actual soil tests made by the United States Department of Agriculture, Bureau of Soils, it was found that the material decomposed readily and afforded a rapid available nitrogen supply. The necessity for the use of all available nitrogenous fertilizer material will make a greater demand and no doubt garbage tankage will be considered equal to other materials for the manufacture of fertilizer.

The values of the by-products produced by the existing reduction plants at present prices will amount to $8,500,000 for grease and $2,250,000 for fertilizer tankage.

From the garbage tankage as produced from all the reduction plants at the present time there can be produced annually about 9,000,000 lb. nitrogen, 25,000,000 lb. bone phosphate lime and 2,500,000 lb. of potash. The grease that is produced is split up into various by-products, the glycerine content being the most valuable. From the garbage grease produced in the plants operating in the United States 8,000,000 lb. of nitro glycerine can be produced from the recovered glycerine, after which from the grease used for the manufacture of soaps there can be produced approximately 200,000,000 12-oz. cakes of soap.

The amount of garbage that is produced per capita per day is small, but when we realize all the wastes that are produced in this form from the total population the amount is tremendous.

There are two sides to the problem of utilization—its cost to the community and the revenues that can be obtained from utilizations—and when we consider the problem of conservation, even if there were no revenues, it is desirable to utilize all valuable elements which otherwise would be wasted.

There is a great shortage of the materials that can be produced from garbage. It is not a question of profit; every community should utilize its wastes and make available from this source everything possible for the country's needs.

The food problem will not end with the war. The conservation of food will always be necessary—the shortage of fats and fertilizer will remain a problem for years to come, and the installation of proper methods for the utilization of garbage will not only contribute to help under present conditions, but remain a permanent benefit for future years. The public will not soon forget the present lessons being taught in economy. The effects of this will remain long after the necessity has disappeared, and no doubt the people will never again waste so much through the medium of the garbage can as they have in the past.

Bids will be asked about Feb. 1 by the Director of Public Service of Toledo, O., for constructing intercepting sewers, containing 6 miles of 42-in. to 72-in. pipe. The improvement also includes a pumping plant, and will involve a total expenditure of approximately $700,000. This is the first portion of a $2,800,000 project authorized on Nov. 6.

The new river and harbor bill, as presented to Congress, calls for appropriations aggregating $29,507,000. Of the total $10,000,000 is for flood control of the Mississippi River, $2,475,000 for improvement of New York Harbor and $5,000,000 for 9-ft. channel in the Ohio River.

The Miami Conservancy District of Dayton, O., has rejected all bids received several weeks ago for the construction of flood prevention works, and will, it is understood, carry out the work by day labor.

American Water Works Laboratories

Interesting data on the laboratory procedure at various water works have been collected by Mr. Jack J. Hinman, Jr., Water Bacteriologist and Chemist of the State Board of Health Laboratories at the State University of Iowa. As the result of a questionnaire sent to all cities of over 25,000 population in the United States and Canada and to some smaller places, information was obtained on an average daily pumpage of more than 3,000 million gallons, of which 2,800 million gallons supplying cities and towns of about 17,000,000 population in 1910, is protected by laboratory control directly under the supervision of the water works officials or their superior officials. The results of the investigation are summarized by Mr. Hinman in a paper presented Oct. 10 before the Iowa Section of the American Water Works Association. An abstract of the paper follows:

In the control of the 96 plans which supply the 2,800 million gallons of water daily, 203 laboratory workers are employed. Of these, 95 have the title of chemist or assistant chemist. Many of the others have the title superintendent of filtration or laboratory director, and so on. Some of these men have had chemical training. Some are engineers who have picked up the rudiments of water examination and carry on such determinations as are necessary for their plants. The preponderance of one-man laboratories is significant and the variety of the work which must be performed is worthy of notice. In addition to the widely differing subjects of bacteriology, microbiology and chemistry of water, miscellaneous chemical and bacteriological work must be entered into. If the laboratory man is also an engineer, so much the better.

Beginning with the laboratory maintained by the city of New York since 1897 and that of Utica, N. Y., established in the same year, we have a rapidly increasing number of laboratories established during the succeeding 19 years. Six plants with a combined average pumpage of 32.5 million gallons per day are now installing laboratories.

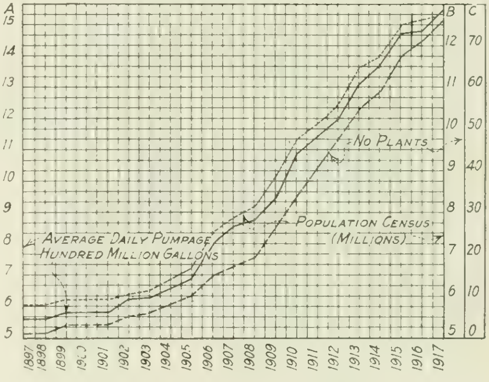
Twelve plants with a combined pumpage of 45 million gallons per day have daily examinations made at outside laboratories. The Metropolitan Water District which supplies Boston and some neighboring communities is a State Commission. It maintains its own laboratory and supplies a little more than 100 millions of gallons of water daily.

Of the plants reporting, 23 are owned privately, 72 municipally and one by the United States Government. The employes of 29 of the municipally owned plants and those of the Government plant are selected by civil service methods.

Rivers and streams form the direct source of 68 plants out of the 96 that have their own laboratories; the remaining sources are lakes, impounded waters from more or less satisfactorily protected water sheds and in a few instances wells and infiltration galleries. Those plants which do not maintain laboratories are nearly all using the water of wells, or impounding reservoirs. None of them supply more than an average pumpage of 16 million gallons per day. One or two pump direct from streams without treatment.

The quantity of the laboratory work done, as well as the particular determinations made, are dependent upon local conditions. For instance, there is very little use in determining iron every day unless the raw water contains that metal in sufficient quantities to precipitate or aid the growth of iron-secreting organisms.

Color and turbidity are usually determined in the raw and treated supplies if the water is coagulated and filtered. These factors give us a somewhat rough indication of the efficiency of the treatment. Alkalinity is another common determination since it limits the amount of coagulant which may be put into a water without the addition of alkaline substances, such as lime, soda ash or bicarbonate of soda. Free carbon dioxide is carefully watched in some plants—particularly those that soften the water, remove iron, or use the iron and lime process. Incrustants and other matters are determined where the conditions justify.



Increase in Laboratory Control of Water Purification Plants by Plant or Department Laboratories.

Occasional complete sanitary chemical examinations are usually considered sufficient, since chemical standards based upon the ordinary factors of a sanitary analysis often mean very little when applied to the routine examination of a treated water. As a matter of fact the oxidation of nitrogen in one of our rapid sand filters is almost negligible and any evidences of pollution which appear in the raw water will be but slightly modified. This state of affairs has led to error on the part of individuals who have attempted to judge a treated water upon the basis of the commonly stated chemical standards. In the case of stored or impounded waters considerable oxidation may take place and the determination of the nitrogen factors may become of greater importance.

Mineral analyses are valuable to users of water for steam making, but those individual firms which enter seriously into the problem of softening a supply usually make their own determinations of a few important factors. There are quite a few boiler plants in most communities which use proprietary boiler compounds, prepared upon the basis of special analyses by the manufacturers of the compounds or upon the examinations of the laboratory of the water plant. Of course, an analysis of the city water showing its excellence for all industrial purposes is a good advertisement.

In general, however, it may be said that a quarterly mineral analysis, a weekly or monthly sanitary chemical analysis and routine determinations of color, turbidity, temperature, alkalinity, free carbon dioxide, free chlorine and similar determinations, ought to meet all demands for chemical examinations. In discussing chemical determinations very little reference to the procedures is necessary since the procedures laid down in the Standards Methods of Water Analysis of the American Public Health Association are so universally followed.

Plankton examinations are made by but 32 of the plants listed. In many cases they are not necessary. Where water is impounded or stored in open reservoirs, routine plankton examinations are useful in indicating the proper time for copper treatment before odors and tastes due to algae growths have become objectionable.

When working with a treated water, the bacteriological determinations are of the highest importance. In most instances it is they which determine the efficiency and adequacy of the treatment given. The arbitrary standards of efficiency applied to water treatment are rapidly becoming more and more rigid. The original filters which the New Chelsea Water Co. of London installed about 1829 were considered efficient, if they merely removed the turbidity of the Thames water. Then a good many years later came Koch's standard of a maximum of 100 bacteria per c.c. This standard was applied to water of all kinds. Later a standard based upon a percentage removal of bacteria came into vogue. The percentage standard of plant efficiency is not satisfactory because when one is treating a good raw water the product may show a low percentage efficiency and yet actually be of the best quality. On the other hand, when the raw water is high in bacteria the effluent may be high also and still be within the limit set up.

Within the past year or so, Wohlmann of the New Jersey State Board of Health has proposed a logarithmic ratio standard which has some advantages. It requires that the ratio of the logarithm of the number of bacteria in the raw water to the logarithm of the number of bacteria in the treated water shall be less than 2.5 to 1. In effect it requires that as the contamination of the raw water increases, the efficiency of operation must increase at a more rapid rate. This standard undoubtedly has its limitations, but it is a convenient device for supervision of operation of a number of plants.

At the same time that the strictly numerical bacterial standards of operation have been evolving, other standards based upon the freedom of the water from certain kinds of bacteria, such as the colon bacillus and the sewage streptococci have been developing also. In our country the sewage streptococci have been worked with but little, while in Europe—particulary in Germany—the validity of our conclusions based upon work on the B. coli has been questioned.

There exists considerable difference of opinion as to the maximum number of bacteria of the colon type which may be allowed in a safe water. The presence of B. coli in one cubic centimeter quantities of the water—except occasionally found organisms—is generally recognized as sufficient to condemn a supply. In addition it has been said that it should be absent from the majority of 10 c.c. samples of the treated water. Constant absence in 5, 10, 50 and even 100 c.c. have been recommended. A few years ago the United States Treasury Department Standard for water supplied to trains carrying passengers in interstate traffic was promulgated. Briefly this standard required that a water should not contain more than 100 bacteria at 37° C. and that not more than one out of five 10 c.c. plantings of the water into lactose broth should show the colon bacillus. This was practically equivalent to setting a limit for colon at one in 50 c.c. This standard was adopted as the majority report of the committee appointed. It aroused considerable opposition from the water men when first adopted, but the Government officials explained that it was not intended for city supplies, but for the small amount of water supplied to passengers. Since then it has been required that bottled spring waters and mineral waters should pass this Treasury Department test.

Many of the plants are working to the Treasury Department standard, a few are working to even higher standards, while some mention only a removal of turbidity and color. Some of the standards are very high and with some waters would be practically impossible to achieve except at a very high cost. This points to the fact that arbitrary standards are apt to be unjust in that they require all waters to reach a certain degree of purity which may not be essential to the safety of the supply.

The practical uniformity of procedure in the chemical determinations of a water analysis has not existed in the bacteriological procedures due to the changes and ambiguity which were introduced by the committee into the second edition of the Standard Methods of Water Analysis. The third edition, which was published this year (1917), is furnished with a much clearer statement of bacterial methods and no doubt will aid materially to clear away the confusion which exists.

In considering the methods used we will find least variation in the plating because the possibilities for variation are not so great. In the body temperature determinations some workers use litmus lactose agar (which gives the opportunity of recognizing acid forming bacteria in addition to making the count); others use the plain nutrient agar. At 20° C. many of the older laboratories use gelatine while others employ agar on account of its lack of trouble with liquefiers and its general convenience. In some laboratories the 37° C. or body count is omitted, while in more laboratories the 20° count is omitted because of the recommendation of committee in the second edition of Standard Methods. Fortunately the third edition has restored the 20° C. count.

In regard to the colon bacillus there is the greatest diversity of method. Some are satisfied with gas formation in dextrose or lactose broth at the risk of calling a considerable number of tests positive when the gas formation is due to other organisms than the colon bacillus. Some prefer lactose bile. Others make confirmatory tests on all gas-bearing tubes. These confirmatory tests vary widely. They may consist in making simple streaks on litmus lactose agar or on Endo's fuchsine-sulphite medium, or they may extend to cultures in a series of sugar media, motility, Gram's stain, and so on and on. The new standard methods have prescribed a method using litmus lactose agar and lactose broth, which will undoubtedly come rapidly into use and enable one to know on reading a report whether any discriminating methods of identifying the colon bacillus have been adopted.

The chief business of most of the laboratories reporting is the control of the water supply, but many of them further justify their existence by making examinations of other substances. Where time permits or sufficient assistance is provided, analyses of the chemicals used in the water purification may be made, as well as the coal, oils and so on. Purchases of these substances under the usual guarantees may be enforced—often at a considerable saving.

In city work, food and drug inspection, the milk supply and its inspection, the examination of cement, paving materials, and all city supplies may be put under the control of the laboratory chief.

Where the laboratory men are trained in that line of work, the city laboratory may make the examinations of the board of health's routine. These include specimens of blood for diagnosis of typhoid, sputum for tuberculosis, throat cultures for diptheria, and so on. Some of the last may be reported from 10 to 24 hours sooner than the state laboratory could report and a difference of this much time sometimes means the loss of a life.

Regarding the filtration plant operation it is hard to draw general conclusions other than that most of the plants are operating efficiently. All do not treat the same sort of water by any means. The variation in turbidity, color, alkalinity and bacterial content of the raw water is very great. The turbidities range up to 12,000, the color to 480 and alkalinity from —90 to 580. The maximum body temperature count of bacteria on the raw water is 210,000; the maximum of the 20° count is 1,000,000 organisms per c.c.

In going over the tables of chemicals used, the variation in the necessary doses is clear. The following short summary of the figures is self-explanatory:

	Maximum in lbs. per million gallons.	Average of maximum figures. Lb. per million gallon.
Aluminum sulphate.	1,275	334.5
Iron sulphate.......	850	349
Lime	2,800	915
Hydrated lime......	852	316
Calcium hypochlorite	20	9.5
Chlorine	6.5	3.2

Other factors of special interest are the sedimentation period and the storage period of the treated waters. For most of the rapid sand plants the coagulation period is less than 6 hours. About one-fourth of these plants have a storage of treated water of less than 1 hour—a condition which may often lead to difficulties in case of fire. The maximum storage of filtered water reported is as great as 10 days, but the average is about 6 hours. The generally adopted rate of operation is 125 million gallons per acre per day.

Nearly $1,000,000,000 Asked for Engineer Operations of U. S. Army

Engineer operations, including the equipment of the corps and railroad and other construction for the expeditionary force in France, will cost nearly $1,000,000,000 in 1919. The exact estimate made public last week in the annual report of Major General William Black, chief of engineers, is $892,000,000 and is based on providing for the engineer operations of 1,500,000 men. Equipment of the engineers with the regular necessary appliances is estimated at $135,000,000. For this work this year Congress appropriated $1,174,000, but a deficiency of $12,100,000 was incurred in outfitting the 10 special railway regiments alone. One of these regiments helped stem the German assaults on the British front at Cambrai last week. Congress provided $94,500,000 for engineer operations this year, but deficiency items totalling $186,000,000 have been submitted.

Cost of Water Main Construction at Pasadena, Cal.

The accompanying table, rearranged from the annual report of the Water Department of Pasadena, Cal., shows the average cost per lineal foot of laying cast iron water mains in that city. The price covers the 4-year period 1914-1917. The table also includes an estimate of the cost of pipe laying based on labor and material prices presumably of September, 1917. Prior to June 30 last common laborers in the Water Department were paid at the rate of $2.40 per 8-hour day. Their pay has now been increased to $2.65. Some of the monthly men also have been increased $5 per month, so that the cost of the labor item in future operation and construction is about 10 per cent greater.

The figures in the table include all charges for pipe, fittings, labor and paving charges. The latter item, it should be noted, gives rise to considerable irregularities in the general average where there is not a great amount of pipe laid.

COST PER LINEAL FOOT OF CAST IRON WATER MAIN CONSTRUCTION BY FISCAL YEARS AND ESTIMATE AT SEPTEMBER, 1917 PRICES

	1914	1915	1916	1917	4-year average	Estimate based on Sept. 1917 prices
4-IN. CLASS B CAST IRON MAINS						
Feet laid	15,71[illegible]	7,621	[illegible]	13,534	[illegible]	
Material	$0.487	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Labor	.222	.211	[illegible]	[illegible]	.247	[illegible]
Auto and team service	.012	.016	.02	.017	.017	.01
Overhead	.059	.063	.097	[illegible]	.067	.12
Total	$0.780	$0.750	$0.846	$0.81	$0.787	$1.12
6-IN. CLASS B CAST IRON MAINS.						
Feet laid	19,878	6,691	12,736	11,3[illegible]4	7,44[illegible]	..
Material	$0.678	$0.668	$0.610	$0.658	$0.677	$1.42
Labor	.257	.376	.296	[illegible]	.278	.30
Auto and team service	.017	.031	.022	.01	[illegible]	.02
Overhead	.076	.096	.117	.07	.088	.126
Total	$1.028	$1.152	$1.045	[illegible]	$1.040	$1.93
8-IN. CLASS B CAST IRON MAINS.						
Feet laid	11,955	1,622	2,748	7,323	23,648	..
Material	$1.042	$1.063	$0.829	$1.014	$1.010	$1.96
Labor	.325	.374	.178	.127	.176	.468
Auto and team service	.018	.031	.021	.02	.020	.022
Overhead	.107	.135	.171	.110	.117	.247
Total	$1.490	$1.603	$1.199	$1.564	$1.527	$2.697
10-IN. CLASS B CAST IRON MAINS.						
Feet laid	3,541	1,831	..	749	6,121	..
Material	$1.290	$1.270	.	$1.41	$1.294	$2.642
Labor	.385	.122		[illegible]	.409	.5[illegible]
Auto and team service	.006	.025		[illegible]	.016	[illegible]
Overhead	.123	.158		.147	.136	.322
Total	$1.804	$1.875	.	$2.087	$1.860	[illegible]
12-IN. CLASS B CAST IRON MAINS						
Feet laid	8,588	....	.	1,674	10,262	.
Material	$1.600			$1.65	$1.658	[illegible]
Labor	.410		..	.61	.418	.64
Auto and team service	.024			.056	.028	[illegible]
Overhead	.180	.		.16[illegible]	.18[illegible]	.408
Total	$2.214	....	..	$2.847	$2.317	$4.487
14-IN. CLASS B CAST IRON MAINS.						
Feet laid			1,200			
Material		..	$1.834			$4.21
Labor			.568			.7[illegible]
Auto and team service			.032			[illegible]
Overhead			.291			[illegible]
Total			$2.725			$5.47[illegible]
20-IN. CLASS A CAST IRON MAINS						
Feet laid		3,053				
Material		$2.732				$6.[illegible]
Labor		.781				[illegible]
Auto and team service		.061				[illegible]
Overhead		.315				[illegible]
Total		$3.889	..			[illegible]

Design and Construction Methods for Copper Lining for City Tunnel of New York Catskill Aqueduct

Slight cracks having developed in portions of the city tunnel of the Catskill Aqueduct of New York City, the Board of Water Supply decided to cover these stretches with a flexible metal lining to insure watertightness. This work is described in the last annual report of the Board, from which the matter following has been taken:

The cracks in the City tunnel occurred in a stretch south of Shaft 18 and another stretch north of Shaft 19. Minute examination of the affected tunnel showed that any appreciable movement of the concrete lining had been confined to the following localities:

1. A stretch about 1,000 ft. long lying under Broadway from a point near the corner of 23rd St. opposite Madison Square to 20th St. 2. A stretch about 200 ft. long under Broadway nearly opposite East 11th St. 3. Two stretches, respectively 60 ft. and 95 ft. long, showing very minor movement, under Broadway near East 12th St.

The maximum movement occurred in the first described stretch, and its most obvious manifestation was a maximum opening of about ⅛ in. at the joint in the concrete lining between side-wall and arch. There were also certain diagonal cracks in various places in a stretch more than 100 ft. long, embracing the point of maximum side-wall joint opening. The remainder of this stretch and the 200-ft. stretch hereinbefore mentioned showed very much less disturbance, but there were so many stretches, more or less separated, but overlapping, on the two sides of the tunnel, where there was a perceptible movement at the joint, that it was impracticable to do otherwise than to make a continuous repair. The last mentioned two stretches, namely, in the vicinity of 12th St., were marked principally by a slight flow through the side-wall joint with considerable red and black deposit, doubtless due to living organisms in the incoming leakage. In these stretches the movements were so slight that the repairs were confined to just the side-wall joints and did not cover the remainder of the periphery.

Studies, Designs and Tests.

The idea of a metal shell not strong enough to take the pressures in the tunnel but furnishing watertightness had been developed from the earliest designs of pressure tunnels for the Catskill Aqueduct. These stretches were, however, the first occasions where a design of this general type appeared to be feasible and necessary. The movements were obviously such as were occasioned by quite local compression of the surrounding rock. After a careful study, it was concluded that a sheet copper lining had the necessary qualities of permanence and flexibility, particularly as corrugations could be introduced which would pull out and so relieve much of the tensile stress in the copper.

The adoption of the flexible lining did not in any way lessen the precautions adopted at the same time for using the more thorough method of consolidating the ground so far as possible by forcing portland cement grout into the rock through many holes drilled through the concrete lining into the rock, especially near larger cracks and in general throughout the affected stretches. The grouting repair was considered the first line of defense and was done very thoroughly, after first cutting out and calking all cracks with lead wire to prevent the grout from flowing back into the tunnel.

A full peripheral copper lining was adopted for the more important stretches, namely, the 1,000-ft. stretch and the 200-ft. stretch. For the two short stretches, where the movement was very slight, it was concluded that it would be sufficient to cover the side-wall joints alone, and a strip about 30 in. wide was used. The thickness of the copper was 5/64 in., and it was furnished in sheets 5 ft. wide and 12 ft. long, all joints being brazed in place. A concrete walk about 4 ft. wide and 4 in. thick was laid in the invert over the copper to avoid injury by traffic. In all the stretches lined with copper, 80 2-in. bronze flap-valves were used, so that when the tunnel is emptied pressure on the outside of the copper will be relieved and will not cause the collapse of the copper.

Longitudinal Corrugations in Copper Lining.—The copper sheets 5 ft. wide and 12 ft. long were placed with their long direction parallel with the axis of the tunnel. It therefore required eight such sheets with eight longitudinal joints to line a stretch of tunnel 12 ft. long; also a ring joint every 12 ft. In each sheet there were placed two longitudinal corrugations having ½-in. depth and radii of curvature. An extra corrugation was also placed in each sheet near the edge to take up the progressively increased lap of the sheet when the longitudinal joints were brazed. The corrugations in one stretch 12 ft. long were joined in the same line with the corresponding corrugations in the next stretch. These corrugations had two purposes: (1) To enable the copper after brazing to be forced back against the concrete lining without putting tension into the copper; and (2) to provide slack so that a slight lifting or expansion of the concrete lining could take place without causing undue tensile stresses in the copper.

To satisfy the latter purpose, the corrugations had to fall within a maximum spacing, otherwise the friction which the plate would have against the concrete lining due to being pressed there by the internal water pressure would be sufficient to cause fracture of the copper lining by tension instead of simply allowing the copper to slip and so to relieve the stress by a flattening of the corrugation. Considering the net internal pressure as about 130 lb. to the square inch and the coefficient of friction, as determined by rude experiments, of copper on concrete to be about one-third, the tensile load on the copper due to a movement of the lining would be, per linear inch, one-half the distance between corrugations multiplied by one-third of the internal water pressure, or 130 lb. With two corrugations per 5-ft. plate; that is, with corrugations spaced about 30 in., the load per linear inch would be about 650 lb. As the copper is 5/64 in. thick, the tensile stress would be about 8,500 lb. per square inch. Considerations of this sort determined the number of corrugations as two rather than one per plate, which brought the spacing to approximately 30 in.

Tests of Corrugations in Copper Lining.—In connection with the design and execution of the copper work, several laboratory tests were made to see how the corrugations behaved under tensile tests simulating conditions which might take place in case the copper lining was expanded by internal pressure, either due to its not hugging the concrete tightly, when installed, or due to a movement of the concrete lining. The first of these tests was of a plain corrugation ½ in. deep and with ½-in. radius fillets. This pulled out readily, and at a stress of 9,000 lb. per square inch in the copper was perfectly flat.

Two other tests were made of samples cut from the lining after brazing and were taken so as to include two corrugations for a length of about 9 in., including the double thickness brazed together at the circular seams. In the first specimen a crack opened in the brazed joint at one of the corrugations when the extension at this corrugation was ¼ in. and at the adjacent corrugation somewhat over ½ in., the stress in the plate being about 3,000 lb. per square inch. The corrugations were entirely flattened at about 9,000 lb. per square inch, but the joints had been further damaged in raising the stress from 3,000 lb. to 9,000 lb. per square inch. In the second test of the brazed corrugations, both corrugations in the specimen were completely flattened without damage to the joint at a stress of about 9,600 lb. per square inch in the copper plate. The lengthening of the specimen due to flattening the corrugations was 0.3 in. at one corrugation and 0.4 in. at the other. The theoretical lengthening due to straightening the corrugation is 0.4 in.

Brazing Copper Lining.—Riveted and soldered upstanding seams were considered and would have been possible, except for the presence of the ring seams. Upstanding seams were not practicable for the ring seams on account of resistance to flow of water and the impossibility of carrying the corrugations across such joints. Tests of flat joints made by soldering showed less toughness than those made by brazing, and furthermore the sweated joints made with solder required a closer contact between the plates than appeared feasible under field conditions, where a mere brazing of the plates against the concrete, without opportunity to squeeze them together as in a vise, would have to be depended upon. Experiments with brazed joints showed that fracture would take place elsewhere than at the brazing. Originally the copper had a strength of approximately 30,000 lb. to the square inch; but adjacent to the brazing it would fracture at from 17,000 to 25,000 lb. per square inch, showing the weakening of the copper due to the hot flame.

Brazing was selected as the most practical method for making strong and water-tight joints with corrugations running through from end to end. Before so determining, experiments were tried in brazing both the longitudinal and ring seams placed in a position directly overhead as would occur at the very top of the tunnel. In this position a speed of about 1 in. of joint per minute was obtained in the brazing experiments. A speed of 12 ft. per hour, about double the speed above noted, was obtained by good braziers on the more convenient joints in the actual work.

It is the common experience in brazing long seams that the lap progressively increases due to the expansion of the heated copper plate and the progressive fixation of the joints at greater laps when the brazing metal cools after the flame goes by. To overcome reduction in periphery of copper due to this difficulty, it was found necessary to use an additional corrugation adjacent to each longitudinal seam. The same tendency was present in the ring seams, but here no roundabout corrugation was possible. Hence the difficulty was mitigated as much as practicable by straining back the unbrazed parts of joints so as to reduce the initial lap. Even with these precautions the ring cracked in places due to the straining and required local rebrazing.

Anchor Bolts in Copper Lining.—Each plate 5 ft. wide and 12 ft. long was erected separately and anchored in position by four ½-in. tap bolts screwed into iron castings which had been previously set in drilled holes and secured by mortar. The end of the anchor casting was so made that after the plate had been erected the position of the anchor could be determined by hammering the copper in its general location where the print of the casting would show through. The copper was then drilled through and the ½-in. tap bolt set. These tap bolts were of composite construction, the threaded portion being steel and the head of bronze. A lead grommet was used under the head to make a water-tight connection.

At approximately every 200 ft. in the long stretch of lining and in each end thereof was placed a ring of sixteen ¾-in. anchor bolts of the same construction as the ½-in. bolt for the purpose of preventing movement of the copper due to such minor changes of temperature as were likely to take place during the period of construction. A maximum temperature range of 10° either side of the temperature of erection was assumed, and a plate of thick sheet copper was placed at each of these anchor-bolts to form a bearing in order that the anchor-bolt might be effective in shear to prevent the temperature movement.

End Diaphragm, Copper Lining.—Each of the stretches of complete copper lining was terminated by an annular diaphragm of ⅛-in. copper plate grouted into a channel in the concrete for a depth of 8 in. The outer edges of these diaphragms were turned parallel with the surface of the tunnel and the copper lining was brazed to them. These diaphragms had two functions, namely, to prevent the leakage around behind the copper lining and to anchor the copper lining against the larger temperature stresses which would result with water in the tunnel varying from, say, 35° to 65° F. It is evident that while the ring stresses due to temperature or other cause are relieved by the corrugations, the longitudinal stresses due to temperature have to be taken up by stress in the copper. A drop in temperature of 30° from the temperature at which the copper is erected will cause a stress of about 6,000 lb. per square inch in the copper.

Flap Valves for Copper Lining.—The 2-in. flap-valves placed to allow inward leakage through the copper lining so as to prevent collapse, but to close so as to prevent outward leakage, are of such a design as to be held against the seat by the weight of the flap or by the counter-weight when placed overhead so that it takes about 0.3 lb. per square inch to open them. These flap-valves are of government bronze and all clearances in the hinges are liberal to avoid sticking by corrosion. Similar valves in the Hudson pressure tunnel were found operating properly after about a year's use with highly mineralized water. To avoid use of these valves it would have been necessary to put in an inner lining of concrete sufficiently strong, say 6 in. thick, to resist the ground-water head. This lining had the triple objection that it would interfere with the elasticity of the copper, would reduce the size of the waterway and would materially increase the time of construction.

Tests for Watertightness of Copper Lining.—The specifications provided for external tests of the completed copper lining by water standing slightly above the top of the copper. Internal wooden bracing was also specified to prevent the collapse of the copper. These tests were conducted successfully, dividing the lining into short stretches for test by means of packing placed outside of the copper at intervals, against which internal bracing squeezed the copper so as to prevent the water used for testing from traveling longitudinally into the next stretch. Each stretch of lining was tested and defects in the brazing repaired, and the lining retested until no further leaks were observed.

Construction Methods.

Proposals were opened Feb. 1, 1916, for furnishing and placing the copper lining in the tunnel. The unit bidding prices are shown in Table I. The work was awarded on Feb. 4 to Lupfer & Remick, Buffalo, N. Y., and on Feb. 23 they began installing plant. Construction was started by driving a short inclined access drift at the foot of Shaft 18 section-valve well to the tunnel at a point about 25 ft. south of the section-valve. All cracks in the concrete lining within and adjacent to the sections to be lined had previously been cut out and calked under an informal agreement for the purpose of cutting off the inflow of water and retaining the grout during subsequent operations. Holes were now drilled around the entire periphery of the tunnel in these sections beginning at the south end of the work. These holes were from 2 to 10 ft. deep, most of them being of the greater depth, and were grouted fro the purpose of filling all cracks and seams, and thus preventing further yielding of the rock or the egress of water.

Grouting was begun on April 12 and was in progress in the tunnel until the end of August. The usual methods of grouting were adopted. Air-stirring grouting machines and high-pressure air-compressors were used, and the grout was generally forced in under pressures of 100 to 300 lb. per square inch. In the 1,200 ft. of tunnel which were copper lined about 1,800 holes, totaling 10,000 lin. ft., were drilled, and about 44,000 cu. ft. of grout, in mixture varying from 2¼ to 8½ cu. ft. of cement per cubic yard of grout, were placed, using about 1,500 bbl. of cement. The leaner mixture of grout was used except in holes taking grout very freely.

On April 25 the erection of the copper lining was commenced at the south end of the work. The copper, which was 5/64 in. thick, was delivered to the work in sheets 5 ft. wide and 12 ft. long, each weighing about 220 lb. Eight of these sheets assembled with the greatest dimension parallel with tunnel made up a complete ring. Before erection each sheet was originally given two longitudinal corrugations of ½-in. radius which provided an excess length about the periphery of the tunnel of about 3/16 in. in each corrugation to insure against rupture of the lining in the event of some slight movement of the concrete.

Each sheet was erected separately, jacked and hammered back against the concrete tunnel lining and held in final position by four ½-in. by 4-in. steel anchor-bolts with bronze acorn nuts with lead washers. The invert sheets were not thus anchored, as the concrete placed after the erection of the lining, was deemed sufficient to hold this portion of the lining in place. After the erection of all but the invert sheets in a stretch of tunnel the longitudinal joints were first brazed and then the circular joints were made. In the invert the process was reversed, the transverse joints being made first and the longitudinal joints last.

The copper sheets were given a minimum lap of 1 in. in the joints. Before brazing, all surfaces in contact in these joints were thoroughly cleaned with an electrically-operated emery buffing-wheel, and with muriatic acid, where the wheel could not reach. The latter method, however, was not used to any great extent on account of injurious fumes given off by the acid when the metal was heated. In order to obtain a satisfactory joint it was necessary in brazing that the two sheets in the lap should be in close contact. To this end there was devised for the longitudinal joints a clamp of 2½-in. heavy iron pipe about 13 ft. long, with ⅝-in. holes spaced about 3 in. apart along its length. A piece of ½-in. round iron about 7 in. long, with a helical spring around it, was placed in each hole and upset slightly inside the pipe to give a bearing for the spring. This clamp could be set up quickly and was strong and self-adjusting. Three jacks were used to hold the clamp in position along the joint, and to obtain the pressure desired. The clamp for the circular joints was similar except that it was 4 ft. long and curved to fit the tunnel.

The brazing material was a composition wire spelter 5/32 in. in diameter, 64 per cent copper, 36 per cent zinc, with a small amount of iron and sulphur. Borax was used as a flux. For the brazing an ordinary oxy-acetylene torch was employed, using a slight excess of acetylene. The pressure used on the torch was about 17 lb. and the temperature obtained varied from 5,000 to 6,000° F. After the borax solution was applied to the joint the brazier started at one end with the torch, heating the copper until the metal was just below the melting point, at the same time feeding the spelter to the joint until the thin space between the plates was completely filled. A minimum width of braze of ¾ in. was required.

TABLE I.—BIDS RECEIVED FEB. 1, 1916, BY THE BOARD OF WATER SUPPLY OF NEW YORK CITY FOR FURNISHING AND PLACING COPPER LINING IN A PORTION OF THE CITY TUNNEL OF CATSKILL AQUEDUCT.

Description.	Unit.	Quantity.	A.*	B.	C.	D.	E.	F.	G.	H.	I.	Average item.
Copper lining around whole periphery of 12-ft. tunnel and all appurtenances, including concrete walk	Lin. ft. of tunnel lined	1,200	$89.00	$110.00	$110.00	$119.00	$115.00	$130.00	$124.00	$110.00	$110.00	$113.00
End anchorages or water-stops for copper lining	Anchorage or water stop	4	250.00	400.00	170.00	650.00	700.00	450.00	350.00	1,000.00	1,000.00	552.22
Copper lining in isolated patches	Sq. ft.	1,000	5.50	4.00	5.50	6.00	5.00	13.50	5.00	7.00	28.00	8.83
2-in. brass flap-valves	Flap-valve	80	5.00	10.00	10.00	15.00	14.00	5.00	25.00	30.00	50.00	18.22
Drilling holes for grouting	Lin. ft.	5,000	1.75	.50	.20	.60	.60	1.00	3.00	1.50	1.50	1.18
Steel pipes for grouting, etc.	Lin. ft.	2,000	.55	.75	.20	.50	.60	.30	2.00	1.50	2.00	.93
Making connections for grouting	Connection	1,000	1.00	2.00	1.50	1.00	3.50	1.00	3.00	4.00	4.00	2.33
Mixing and placing grout	Cu. ft.	5,000	.90	.30	1.00	.60	.60	1.00	2.00	.50	2.00	.99
Removing and replacing riser valves	Riser valve	2	500.00	200.00	250.00	1,000.00	3,000	500.00	1,500	16,000	10,000	3,661.11
Amounts of bids			$130,050	$146,300	$147,380	$162,600	$163,620	$184,300	$192,200	$194,400	$213,500	....

Time: 5 months. Bond required: $60,000. *Awarded contract. A—Lupfer & Remick. 594 Ellicott Sq., Buffalo, N. Y. B—The Marble Arch Co., 216th St. and Broadway, New York City. C—Booth & Flinn, Ltd., 17 Battery Pl., New York City. D—Chas. Meads & Co., 38 Park Row, New York City. E—Henry E. Fox Construction Co., 81 East 125th St., New York City. F—Mason & Hanger Co., 52 Vanderbilt Ave., New York City. G—W. F. Plass & Bro., Inc., 145-151 West 18th St., New York City. H—William Heyman, 15 Exchange Pl., Jersey City, N. J. I—Ward & Tully, Inc., 38th St. and 10th Ave., Brooklyn, N. Y.

An interesting feature of the brazing was the "creep" of the sheets due to the heating effect of the brazing. When the work was started at one end of a 12-ft. section, after jacking the entire joint together with the minimum lap of 1 in. it was found on the completion of the brazing that the lap had increased to 1½ in. at the other end with a consequent drawing away of the sheet from the wall of the tunnel between the joint and the next row of anchor-bolts. This difficulty was partially overcome by applying more pressure to the joint, and was finally obviated in the 1,000-ft. section by inserting another corrugation near the edge of the plate which permitted the copper to be hammered back after brazing without losing the desired fullness provided in the original corrugation.

The sheets in the southerly, or 200-ft., stretch and in the patches were erected with the original two corrugations only, and were placed in contact with the concrete after brazing by hammering and slightly stretching the copper between points of support. The creeping tendency was counteracted somewhat in circular seams by removing all but the lowermost anchor-bolts of the 12-ft. ring of copper about to be brazed, drawing it away from the completed portion ⅛ in. at the bottom where brazing was started and ¾ in. at the top where it was completed. The creep resulting from the heat treatment brought the sheets in the lap back to their proper relations. Two braziers were employed in this operation, working away from each other toward the top of the circular joint.

From time to time sections of the brazed joint were cut out and tested to determine its strength which was found to vary from 1,345 to 2,370 lb. per linear inch; in most cases the copper tore before the brazing gave way. The ends of the copper in the 1,000-ft. and 200-ft. stretches were brazed to copper diaphragms grouted into channels cut in the concrete lining of the tunnel. At the ends of each section of the copper lining and at intervals of about 150 ft., ¾-in. by 5-in. steel anchor-bolts with brass cap nuts, with 2-in. by 5-in. by ⅜-in. brass plates between the brass nuts and the lining, were substituted for the ½-in. anchor bolts, their function being to hold the copper lining in place against temperature changes. In the case of patches, sheets of copper about 44 in. wide and of varying length, were placed and made to conform to the concrete surface. The edges of the sheets were brazed to strips of copper already placed and grouted in the concrete lining.

A total of 14,000 lin. ft. of joint was brazed at an average rate of about 60 ft. of horizontal and 48 ft. of circular joint per brazier and helper per 8-hour day. Approximately 3 cu. ft. of oxygen, 3¼ cu. ft. of acetylene, and 2 oz. of spelter were used per foot of horizontal joint, the circular joint requiring 20 per cent more of each.

In the copper lining 2-in. bronze flap-valves spaced about 25 ft. center to center were inserted about 18 in. above the invert and at intervals of 100 ft. in the arch for the purpose of relieving the external pressure on the copper lining when the tunnel is empty. A number of flap-valve bodies without the flap, but closed with brass plugs, were placed by the contractor along the lowest part of the invert through which the accumulated water between concrete and copper linings in the lower part of the invert could be drained off. Openings about 8 in. square were placed in the concrete sidewalk for access to these plugs.

Before accepting the copper-lined tunnel, the lining was tested by external water pressure equivalent to a 3-ft. head on the arch. Wooden segments, spaced 16 in. center to center along the axis of the tunnel, and braced from roof to invert, were placed to support the copper lining while under test. Wedges were driven between the segments and the copper hammered until it was in contact with the concrete. The 200-ft. stretch was tested in one section, and the 1,000-ft. stretch in seven sections. The patches were also similarly tested. All leaks uncovered by these tests were repaired and the hydrostatic test repeated until the section was tight.

A large proportion of leaks, in general very minute, were in the circular seams, especially at the longitudinal corrugations, and their repair was difficult as the stresses produced by the expansion and contraction of the metal under local heating were in many cases too great for the brazed joint to stand, and another crack would develop near the one being repaired. After satisfactory external tests on the lining were completed the tunnel was thoroughly cleaned, the access drift at Shaft 18 closed, and at the end of the year the contract was completed except for removal of plant and cleaning up. The total amount of estimates passed on the contract was $163,756, an amount 27 per cent greater than the amount authorized to be expended under the contract. This is accounted for by the large quantity of grout used over that originally estimated. The contractor's force averaged 68 men per day, the maximum employed being 125 and the minimum 11 men.

Cost of Cathbasin Cleaning with an Auto Eductor

Machine cleaning of sewer catch basins is being done by the Bureau of Sewers of Chicago, of which Geo. E. McGrath is Superintendent, at a cost of about $1.30 per catch basin. The average cost of this work by hand during the past 4 years has been $3.24 per catch basin. The machine used is known as the auto eductor. It consists essentially of a centrifugal pump and suction device attached to a motor truck. The pump is driven by a power take off attached to the driving shaft of the truck.

The following statement, compiled from the daily reports on file in the Bureau of Sewers, shows the work performed and the cost of operation of the auto eductor for the 3-month period of August, September and October, 1917:

COST OF OPERATION.

One chauffeur, 3 months @ $115.00 per month	$ 345.00
One laborer in charge of auto crew, 2 mos. @ $3.60 per day	176.78
One laborer in charge of auto crew, 1 mo. @ $4.60 per day	112.95
One laborer, 3 mos. @ $3.30 per day	243.08
Total for labor	$ 877.81
Repairs, gasoline, oil, etc	308.08
Interest at 4% on $7,000 (cost of eductor)	70.00
Depreciation at 10 ct. per mile for 1,380 miles	138.00
Grand total	$1,393.89

WORK PERFORMED.

Number of miles traversed, 1,380.
Number of catch basins cleaned, 1,073 @ $1.299.
Number of cu. yd. removed, 1,763 @ 79 ct.

The device is the invention of Mr. G. W. Otterson of Springfield, O. The truck with eductor and all attachments is built by the Kelly-Springfield Motor Truck Co., Springfield, O.

New Record on Chicago Sewer Construction

By JOS. E. LOVE,

Assoc. Mem. Western Society of Engineers.

Though handicapped by exceedingly unfavorable conditions which generally accompany the end of the working season, the Ryan Co. of Chicago was recently successful in making a new record for a single day's work on sewer construction in Chicago. For some time the maximum length of sewer dug and laid in one day was 1,320 lin. ft., but on Nov. 20, the Ryan Co., with its well organized crews, added 18 ft. to this record. According to the measurements of the engineers of the Board of Local Improvements, 1,338 lin. ft. of ditch, 32 in. in width and averaging 8½ ft. in depth, was excavated, and 660 ft. of 15-in. and 678 ft. of 12-in. vitrified sewer pipe laid. All of this work was on a straight alignment. In addition to the trenching and pipe laying 5 brick manholes were constructed and 1,260 lin. ft. of the sewer backfilled. Under a thin surface of black loam the soil was a yellow clay which was extremely wet from the heavy October and November rains. This condition of the clay made fast work difficult and, moreover, necessitated extra bracing precautions to prevent the sides from caving.

Excavating Machine Used on Record Run.

On account of the additional bracing required the work was delayed 1 hour, thus reducing the nominal 8-hour day to an actual working period of 7 hours. On the digging a No. 1 Austin excavator was used and a drag-line with a slip-scraper, rigged up by the contractor, did the backfilling. A total force of 23 men under one foreman was employed, the distribution among the various crews being as follows:

Trenching and Pipe Laying Crew.

1 pipe layer.
1 bricklayer.
3 fillers.
1 bracer and sheeting puller.
4 top men.
1 extra man.
1 engineer on trencher.
1 fireman on trencher.

Manhole Crew.

1 bricklayer.
1 mortar mixer and carrier.
1 helper.
1 brick tosser.
3 laborers on digging.

Backfilling Crew.

1 engineer on backfiller.
1 fireman on backfiller.
1 laborer.

Besides these crews, a helper with a team was employed on miscellaneous work. This stretch of sewer was a portion of a contract in Clearing near 63d St. and Austin Ave. for the Board of Local Improvements of the city of Chicago. The contractor has expressed the belief that when working with fairly favorable earth conditions and in summer weather 1,800 to 1,900 ft. of sewer construction in one day can be attained in this locality.

City Management As a Profession

At the recent annual meeting of the City Managers' Association a very interesting committee report on city management as a profession was submitted by Mr. H. M. Waite, City Manager of Dayton, O. A synopsis of this report follows:

Commissions have made city management a profession by showing a willingness to go outside of their own communities for city managers. City managers are receiving invitations to other towns and there now have been seven cases of transfer, showing that the tendency is to recognize the existence of professional experience. City managers recognize that a career lies before them in this field and are seriously building up their experience to make it a life career.

The profession can be said, therefore, to have come into existence with every indication of continuance. It is interesting to note from the registration at the city managers' convention this year that out of 25, about 95 per cent are engineers, indicating that commissioners turn to the municipal engineer for managers.

Qualifications for City Managers.—Small cities (under 20,000 population), preferably engineer, executive ability is first essential. Larger cities (20,000-200,000 population), executive ability first essential, engineering less essential. Large cities (over 200,000 population), executive ability prime essential.

The committee believes that city manager qualifications may be from present experience, classified as follows:

Experience shows that actual experience is considered as most valuable equipment.

The attempt to lay out courses by universities for training city managers is handicapped by the fact that a major requirement is native executive ability, which cannot be taught. A university cannot train a man to be an ordinary business executive. It cannot propose a man to step into the management of a city. It can train him to step into the management of a village. The attempt to lay out a course reveals the fact that the entire field cannot be covered by thoroughness in every branch that confronts a manager.

It is essential, therefore, that rather than give a man a smattering of all the many subjects, that he be thoroughly trained along some one or two lines, such as engineering or accounting, or whatever may be his natural bent, the balance of his time in college being devoted to obtaining a general knowledge of the other fields.

The committee believes the National Municipal League could fill a useful function by maintaining a roster of city managers with their experience as well as a roster of competent men who are desirous of entering this field.

A conference of experts was held last week at Chicago to consider to what extent the plan of feeding garbage to hogs as carried on near the National Army cantonments is practical near smaller cities.

Factors Affecting Economical Use of Water in Irrigation

Experiments were conducted in eastern Oregon in 1915-1916 by the Oregon Agricultural College to determine the various factors affecting the economical use of irrigation water. The results of these studies are given in an Experiment Station Bulletin, prepared by W. L. Powers, Professor of Drainage and Irrigation. The following summary of the factors is extracted from the bulletin:

Soil texture affects the irrigation requirement. The coarser soils require more water, and these soils generally have a low-water requirement and a comparatively low amount of surface area pore space, organic matter, and are apt to be medium in fertility. The light, frequent irrigations required on these soils necessitate more waste, and it is impracticable to use as small an amount of water on these soils as on the soils of finer texture.

The kind of crop affects the amount of water required. Alfalfa and other meadow crops are requiring relatively large amounts of water; grain and field peas, but medium amounts; cultivated crops, such as potatoes, still less.

The altitude and accompanying climatic conditions affect the irrigation requirements. While the data are not sufficient for absolute deduction, it may be said that in general for the same soils and crops where 3 ft. depth is needed per season up to 2,000 ft. elevation, 2 ft. is a reasonable amount at 3,000 ft. elevation, and 1½ ft. for each season is a reasonable amount for elevation of 4,000 ft. or more. Drying or other effects of the weather are intensified at the lower altitudes.

Soil fertility is one of the most important factors affecting irrigation requirements. Where there is a good supply of available plant food, the plant does not have to exert the energy to make the root growth or consume nearly the amount of water to secure the nourishment that goes to form a pound of dry matter. Frequently, in the experiments, applying the simple fertilizer needed has saved from a quarter to one-half the total irrigation or doubled the returns for each unit of water where fertilizer was applied. This is especially true on the lighter types of soil.

The time of irrigation affects greatly the efficiency of the water applied since irrigation, like cultivation and other things, is worth more when applied just at the right time. In previous experiments at Corvallis irrigations were applied according to the moisture content of the soil and in different degrees of dryness. It was found that, for this soil, on the potato plot as much as 50 bu. more an acre could be secured by applying water just at the right time. This, for the brown silt loam at Corvallis, was when the moisture content of the first foot dropped to the 20 per cent point. Clover gave the best returns for the given amount of water, applied in similar experiments, when the moisture content of the first 2 ft. had dropped to the 14 per cent point, or when soil contained 14 per cent moisture in per cent dry weight.

The amount applied at each irrigation will affect the economical use of water or irrigation requirement. If the amount applied is in excess of the capacity of the soil strata within reach of the roots to retain it, deep percolation loss is sure to result. This has been one of the chief sources of waste encountered in the investigation. Coarse textured soils or those with gravelly substrata should have a distribution system that will permit or supply comparatively light and frequent applications which can be retained in the soil without percolation loss.

The frequency of irrigation is related to the time and amount for each irrigation. Irrigation should be applied only when the moisture content drops to near the wilting point for the particular soil and crop and in sufficient amounts to fill up the excess point in all cases except where flood irrigation in the early spring is necessary to retain as much water as possible in the soil reservoir. This would be true in the absence of artificial storage for summer irrigation.

The method of applying water affects the water requirement. The head and length of run should be such that the plot irrigated can be covered by the time the irrigation has wet up the root zone of the crops. A high head forces over the land rapidly and is necessary in flood irrigation or in irrigating loose soils. The longer length of run gives more time for soaking during irrigation on the heavier textured soils. Longer runs can be used on more sloping land and shorter runs with a higher head should be used on the flatter lands in order to cover the land without waste. In many valleys in eastern Oregon the flooding system could be improved by the introduction or extension of the trip border method of flooding. On the small farm and with a small head the furrow system will save water better than flooding systems.

Crop variety and the date and rate of seeding affect irrigation requirements. The best varieties of best adapted crops will give the most efficient use of water and the most economical returns under irrigation.

The kind and amount of cultivation. It is important for the irrigated farm to have a moderate proportion of cultivated crops; for these are crops of low water requirement which permit intertillage, kill weeds, and control evaporation from the soil. This cultivation should be given promptly to be most effective and as soon after irrigation as the soil is dry enough to crumble and form a mulch. Level cultivation gives less evaporating and soil surface area, and everything that possibly can be cultivated should be gone over with a light cultivation after every irrigation and every rain that crusts the soil and destroys the mulch. A light weeder can be used for this purpose in grain and even in corn and potatoes till crops are 10 or 12 in. high.

The kind of ditches has a bearing on the amount of water used. Small, direct ditches, which carry the water to the point of application, will save water as compared with broad, shallow ones, which expose the water to evaporation and percolation loss.

The skill and economy of the irrigator are important factors affecting economical use of water. Careless use of irrigation water results in a great loss, whereas skillful management will almost wholly prevent loss by drainage.

Economical use of water depends upon the methods of purchase and delivery of water. The best plan is to practice rotation in use of water and get a high head, to secure an even and rapid distribution while the water is on the farm. A higher duty is obtained by this method rather than by having a small, continuous flow during the entire season. A higher duty may also be obtained where the irrigator pays at least maintenance charge in proportion to the actual amount of water used, for this invites economy in the use of water.

It is more important for the irrigation farmer than for the rainfall farmer that a careful system of crop rotation be practiced. With irrigation, the crops removed are generally large and large amounts of refuse must be returned to the land. With irrigation, also it is entirely feasible to build up and keep the soil in a higher state of fertility than is possible without irrigation. The rotation of crops permits plowing up the meadows to market the nitrogen accumulated by the legume crops and this deep plowing increases the usable water capacity and liberates plant food.

Generally a diversity of crops, including some cultivated cash crops which use but little water, will give more cash returns for each unit of water used.

Indirectly, anything which affects the evaporation, percolation, or transpiration of soil moisture will have an effect upon the irrigation requirements. The aim should be to secure efficient use of all the rain, irrigation, and soil water employed.

Unusual Failure of Reservoir's Roof at Pasadena, Cal.

An unusual failure of a wooden roof covering a reservoir at Pasadena, Cal., is described in the last annual report of S. B. Morris, Chief Engineer of the Water Department. The roof was on the Wilson Ave reservoir.

This reservoir was constructed during 1909 and 1910 by the Lake Vineyard Land & Water Co. and was acquired by the city in 1912. It has a capacity of 13,000,000 gal. The dimensions are 414x283 ft., 17 ft. deep, with 1:1 slopes. The lining is 4 in. of concrete, except the south wall, which is 6 in. thick, all without reinforcing. The reservoir cost $31,000, including the wooden roof.

The roof was constructed of 1-in. x 12-in. and 1-in. x 10-in. rough Oregon pine boards laid on 2-in. x 8-in. joists 16 ft. long on 4-ft. centers, which were placed on two 2-in. x 10-in. girders spiked together and on 15-ft. 10-in. centers. Posts consisted of 2-in. standard weight pipe dipped in asphaltum and capped at the lower end, while the upper end penetrated about midway into a 6-in. x 6-in. x 3-ft. corbel. The sills were not fastened in any way to the concrete, nor was there any bracing of any kind used in the roof.

Inspection of the roof a few minutes after its failure clearly showed the cause of the collapse. The morning of the accident was perfectly clear and quiet, nor had there been any storm of any kind for some time. The joists at the east and west banks were supported by 4-in. x 4-in. girders resting on 4-in. x 4-in. posts 6 in. high on the 2-in. x 6-in. redwood sill. Earth and gravel on top of the concrete gave clear evidence of the position of the redwood sill prior to failure. For nearly the entire length of 414 ft. on the east side the sill projected only 2 or 3 in. on the concrete, and was very much raised on the outer edge, thus tending to overturn the 4-in. x 4-in. x 6-in. posts. This action had apparently gone on for months with the strains of various temperatures and dampness. As soon as the roof started to push westward it slid down the 1 to 1 slope, the whole roof moving as one unit, and pushed over the west bank for one 16-ft. section, the next 16-ft. section rested against the slope, and the other sections floated on top of the water, the reservoir being about half full. The only boards broken were a few along the west bank where the roof broke into two 16-ft. sections extending the whole length of the reservoir.

The roof was removed by allowing the water in the reservoir to run out until the roof rested on the bottom, after which all lumber was removed, allowed to dry, and then dipped in a crude oil preservative, thus putting it in better condition than before the collapse.

In rebuilding the roof it was decided to use 6-in. x 6-in. redwood posts instead of the 2-in. pipe posts, which were in bad shape from pitting. The pipe was sold for 10 ct. per foot, which was sufficient to pay for the 6-in. x 6-in. redwood posts. A summarized statement of the cost of reconstructing this roof is shown in Table I.

TABLE I—COST OF SALVAGE AND RECONSTRUCTION OF COLLAPSED ROOF OF WILSON AVE. RESERVOIR.

Book value of roof at time of collapse March 25, 1917			$7,291.67
Value of materials recovered from wreckage:			
Appraised value of materials used in reconstruction	$3,427.87		
Appraised value of materials taken to store room	31.15		
Materials sold	566 50	$4,025.52	
Cost of recovering materials from wreckage		719.93	3,305.59
Net loss			$3,986.08

COST OF NEW ROOF CONSTRUCTED BY WATER DEPARTMENT.

Description.	Labor.	Auto and team service.	Material supplies.	Cost per 1000 ft. B.M.
Transporting and setting up dipping kettle for dipping lumber	$ 12.98	$ .75	....	$ .063
Cost of dipping lumber	242.96	11.70	$ 261.84	2.356
Labor and material used in constructing roof	925.38	12.30	5,079.43	27.442
Hauling and transportation of materials	69.10	42.75	.21	.511
Engineering and supervision	184.04	42.40	.60	1.035
Overhead	......	.....	....	2.329
Total	$1,434.46	$109.90	$5,342.08	$33.736
Cost per 1000 ft. B. M.	$ 6.542	$ .501	$ 24.364	
City's appraised valuation Nov. 1, 1912	3,134.26	......	4,820.67	
Construction cost to Lake Vineyard Land & Water Co.	3,264.85	.....	5,068.49	

Number of feet of lumber used in construction, 219,262.
Average cost of lumber per 1,000 ft., $21.69
Total cost per square foot of roof, $0.0552.

Tables of Velocity of Water in Open Channels.—The State Reclamation Department of Texas has recently published a very complete table giving the mean velocity of water in open channels, derived from Kutter's formula. The table is known as Bulletin No. 6, August, 1917, by Arthur A. Stiles, State Reclamation Engineer, Austin, Tex. The velocities cover a very wide range. They are given for 30 different hydraulic slopes; for values of hydraulic radius ranging from 0.2 ft. to 50 ft.; and for values of the coefficient of roughness ("N") ranging from .006 to .080. The velocities are given in feet per second to the nearest first and second place decimals. It is thought that the tables will fit almost every conceivable case arising in actual practice, and will therefore practically do away with all computing from the formula. The table is designed to facilitate the work of the State Reclamation Department, and is of especial interest to levee, drainage and irrigation engineers. As the bulletin is a State document, it is not for sale, but is available free, as long as the supply lasts, to all persons who have a real need for a work of this character.

The garbage at 13 of the 16 National Army cantonments is sold by contract at a rate which gives a return to the Government estimated at $416,000 annually. The purchasers of the garbage feed it to hogs.

Cement Joints for Cast Iron Water Mains

In 1912 the city of Long Beach, Cal., began the use of cement joints with its cast iron water pipe. At the present time the city has 60 miles of mains, ranging from 4 in. to 24 in. in diameter, laid with joints of this type. All these pipes are under pressures ranging from 40 lb. to 80 lb. per square inch and are giving perfect satisfaction. In a paper* presented April 18 last before the American Society of Civil Engineers Mr. Clark H. Shaw, Hydraulic Engineer Long Beach Water Department, describes Long Beach's method of making these joints. The following is an abstract from Mr. Shaw's paper:

In making the cement joint the pipe is placed and spaced in the usual manner. A thin backing of the best dry jute is used instead of oakum, as the jute is free from oils and grease (which should be avoided). A Portland cement, conforming to the specifications advocated by the American Society for Testing Materials, is used. The dry cement is placed on a piece of canvas (usually a cement sack ripped open) and moistened just so that when thoroughly mixed by hand it will be of such a consistency that when gripped tight it will hold the form of the hand and when dropped 12 in. it will crumble. The canvas containing the cement is placed under the bell and the cement is tamped into place by hand with a caulking iron until the bell is about half full. It is then caulked with heavy blows until the cement is thoroughly packed in the back of the socket. This process is continued until the bell is packed solid out to the face. A small bead of neat cement in a plastic condition is then put on, using the caulking iron as a trowel. As soon as the initial set of the cement in the bead has taken place the joint is covered with earth to protect it from the air and sun. In backfilling, the excavated material is always settled with water, which helps to cure the exposed portion of the joint.

In Mr. Shaw's opinion, the bead is essential, as the cement packed in the bell is so dry that without protection it would absorb moisture from the water used in settling the trench, and it is believed that, should the joint develop seepage when the pressure is put on in the main, the cement, being dry, would expand and aid materially in keeping the joint tight.

Experiments on cement joints constructed without the head showed that, 24 hours after completion, they absorbed water readily. In cases where seepage has developed and has subsequently closed, it is assumed that the dry cement absorbed the moisture from the inside, expanded, and filled the seepage pores.

About 20 per cent of the cement is wasted by falling off the canvas or being thrown out by the caulker. If any dust or earth from the trench falls on the canvas or in the cement, it is immediately taken out, together with enough cement to make sure that the remainder is clean. In mixing the cement with water, care is taken that there shall be no lumps in the material, no matter how small. If any cement is left on the canvas when a joint is completed, it is used on the next joint, provided the work is continuous, otherwise new batches are made. Special blunt caulking tools are used.

The joint is allowed to stand 48 hours before the pressure is turned on and the main is put into regular service. Cement joints have been used with satisfactory results, however, 12 hours after completion, but this is not considered safe practice.

At San Diego, Cal., a pressure test was made by caulking a 6-in. cast-iron tee, one side of the tee being filled with a plug and each of the two ends filled with short lengths of cast-iron pipe with plugs caulked in the ends. As the pieces of pipe caulked in the tee were scrap ends cut from other pipes, they had no bead on the joint end, and, notwithstanding the fact that the joint was made with smooth pipe, it took a pressure of more than 300 lb. per square inch to force the pipe out. The test was made about 48 hours after the joint was made.

In another test, made at Winnipeg, Man., three lengths of 6-in. pipe were laid with four cement joints, on Jan. 13, 1916. After 6 days, pressure was put on the pipe, in increments of 25 lb., and the joints were found to show no leakage or moisture, up to 125 lb. At 150 lb. one joint showed moisture on the surface of the cement.

On Jan. 24 another test was made, and at one joint moisture appeared at 175 lb. On Jan. 31 this joint showed moisture with 200 lb., and also on March 15, with a pressure of 225 lb. This joint was the weakest of the four. The pressure was kept on the pipe about one-half hour in each case.

The cement joint can be taken apart in a very simple and economical way. The pipe is uncovered about one-half, or a little below the center. At the joint where the original bell-hole was dug, the trench is usually made wider on the sides (but not deeper under the pipe, in order to permit the caulker to work at the joint. The upper half of the joint is cleaned out with a cape-chisel; then, with tripod and blocks, the free end of the pipe is raised until the lower half of the joint breaks free from the bell. The pipe seldom has to be pulled out of the bell, as it nearly always works itself out as the free end is lowered. If portions of the cement stick to the spigot end of the pipe, or fail to be entirely crushed in the bell, it is a very simple matter to clean out the bell with a cape-chisel, or knock the cement from the spigot with a hammer.

On occasions, after a joint has been cemented tight in the line, it is necessary to cut it out entirely (such as for laying a valve on its side; turning a tee or Y in another direction; adjusting a tee to conform to or meet a grade; avoiding a sewer connection or any other unforeseen obstacle). Table I has been compiled from records of the actual time spent in doing such work.

At Long Beach unit costs have been kept on all construction, covering nearly the entire 60 miles of

TABLE I.—TIME REQUIRED FOR ONE MAN TO DIG OUT A COMPLETE CEMENT JOINT, WITHOUT REMOVING FITTING OR GATES FROM THE LINE.

Size.	Time.
4-in.	18 min
6-in.	22 min
8-in.	26 min
10-in.	30 min.
12-in.	38 min.
14-in.	48 min.
16-in.	60 min.

TABLE II.—DATA RELATIVE TO CEMENT JOINTS.

Size of pipe.	Rings of jute per joint.	Jute per joint in pounds (approximate.)	Number of joints per 94-lb. sack of cement *	Number of joints per 8-hour day one caulker
4-in.	2	0.14	24	50
6-in.	2	0.19	18	42
8-in.	2	0.24	14	34
10-in.	3	0.43	11	28
12-in.	3	0.51	8	24
14-in.	3	0.58	7	20
16-in.	3	0.66	6	[illegible]
18-in.	[illegible]	0.73	5	[illegible]
20-in.	3	0.80	4	[illegible]
24-in.	3	0.95	3	[illegible]

*Including the 20 per cent of cement wasted or left over.

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* Cement Joints for Cast Iron Water Mains. Proceedings Am. Soc. of C. E., pp. 433-443.

cast-iron water mains. Table II has been carefully compiled from these unit costs, and presents data concerning cement joints.

Pollution of Drinking Water from Failure of Connections in Manufacturing Establishments

Two instances of the pollution of drinking water in manufacturing establishments in Rhode Island during the past year, through failure of connections between the industrial and drinking water systems, are cited by Stephen De M. Gage, Chemist and Sanitary Engineer of the Rhode Island State Board of Health in the last quarterly bulletin of the Board.

The first instance occurred in a large manufacturing plant in Providence late in 1916. The drinking water supply for this plant is from a system of driven wells and is of excellent quality. The water for industrial and toilet purposes is taken from a large pond which is polluted to some extent with manufacturing wastes and which in the summer time is also heavily impregnated with algae. On the advice of the State Board of Health, these two supplies had supposedly been entirely separated, but one cross-connection located in an inaccessible place was forgotten and was not removed. In some way the gate on this connection was opened and for a short period the pond water was pumped into the drinking water supply. The character of the two waters was so radically different that the accident was discovered almost immediately, although not before a considerable number of employes had drunk the water. Fortunately the pond water, while decidedly unpalatable, was not dangerously polluted and the only ill effect was extreme nausea for a short time among those persons who had used the water. The dangerous cross-connection between the two supplies was at once removed.

A second instance of pollution of drinking water through a cross-connection with an industrial water supply occurred in the Woonasquatucket Valley during the past summer and was the cause of 4 deaths and over 40 cases of typhoid fever. In this instance the drinking water supply for the mill, and also for an adjacent village, was derived from a large well on the mill property. The industrial water supply was taken from the river, into which is discharged the sewage from the mill and the village, at a point only a short distance above the intake for the pumps. Every precaution had been taken by the manufacturers to protect the well from pollution, and the water as drawn from the well was of undoubted purity. There were, however, two points in the mill where the well supply was cross-connected with the river supply, to permit the river water to be pumped into the village mains in case of fire and to permit either supply to be used in the lavatories and toilets. As soon as the epidemic was discovered, samples from a number of points on the water supply were collected for analysis, but at this time no evidence of contamination could be detected. As every person who contracted typhoid was either employed in the mill, or lived in the village and used the water from the mill supply, and as all other sources of contagion were eliminated either by the distribution or history of the cases, and, furthermore, as there had been a previous case of typhoid in the village a short time before, there is little question that the epidemic was the result of a temporary pollution of the drinking water through one of the cross-connections.

City Water and Light Plants Operated on Same Basis as Private Utility

The city of Holland Mich., operates its water works an lighting plants on a businesslike basis. The municipality is required to pay for water and light at the same rate as private consumers. Furthermore the water works and light plant are placed on the tax rolls and assessed the same as other industries. In revising assessments this fall the value of these properties were increased for $300,000 to $452,000.

The water department is under the control of the Board of Public Works, which also has charge of the electric light and fire alarm departments and also of the sanitary sewer system.

Each month when bills are being prepared for commercial lighting, power or water works consumers, bills are prepared in exactly the same way for presentation to the Common Council covering the city's use of water and electric service.

The city is charged for fire protection on a basis of the number of hydrants in service, there being at the present time 313 in use. The rate charged per annum is $35 and bills are rendered monthly.

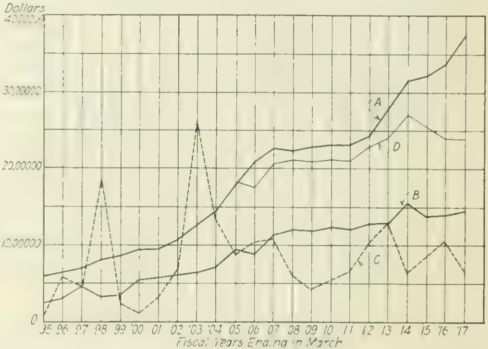

Fig. 1—Curves Showing Increase of Operating Revenue and Operating Expenses, Together With Annual Expenditure for Permanent Improvements.

Street lighting is done by means of 250-c.p. type "C" Mazda lamps, there being 285 in service and the charge per annum is $35, bills being rendered monthly.

Water for street sprinkling is paid for on the basis of the number of wagons used, the charge being at the rate of $150 per 600 gal. wagon per season. At the upper end of each lateral sewer there is a connection to the water main through a 1½-in. valve which is operated by hand at stated intervals for the purpose of flushing the sewers. These stations are referred to as "flush ends" and the water department receives $7.50 per annum per flush end.

The City Hall and all other public buildings are metered for both light and water and charges are made in the regular way at the regular rate.

On the other hand, the Bureau of Public Works, on Oct. 16 paid to the city government city and school taxes on the light and water plant, the total taxes being $5,761.91, of which $3,272.70 is for the light plant and $2,489.21 for the water plant. This amount represents a rate of $12.75 per $1,000 of the total valuation of the plant which was set at 82 per cent of the total investment. The two departments also pay interest on all outstanding bonds.

According to the annual report of the Board of Public Works for the fiscal year ending March 19, 1917, the total operating revenue of the Water Department for that period exceeded the previous year's earnings by 10.37 per cent. The increase of total revenue during the past 10 years has amounted to 66.33 per cent, while for a period of 20 years the increase has been 469 per cent. Curves showing the increase of operating revenues and operating expenses are reproduced in Fig. 1. The average prices received for all water covered by the commercial supply earnings for 5 years have been as follows:

Calendar year.	Commercial supply earnings.	1000 Cu. ft.	Average price per 100 cu. ft.
1912	$17,196	22,397	$0.0768
1913	19,865	29,043	.0684
1914	21,049	23,227	.0907
1915	22,465	20,831	.1078
1916	25,804	25,862	.1002

The present rate went into effect on July 1, 1914, so that one-half 1914 was under the old rate and one-half under the new rate. The lower price received in 1913 as compared with 1912 and 1916 as compared with 1915, is due to the larger amount of water sold; that is, the more the total amount of water sold, the less will be number of "minimum" charges. The average cost per 100 cu. ft. on a bill rendered for the established minimum charge, will naturally be higher than the published rate. The old rate was 6 ct. per 100 cu. ft. and the new rate is 9 ct. The sliding scale is such that but very few users come under a lower rate.

R. B. Champion is Superintendent of the Board of Public Works of Holland, Mich.

Water Rate Revision by Municipal Works*

A printed report of a study of the rate question was published by the writer in 1915 for the Waltham Water Department and this outline is offered to show a method of treating the problem in municipal works, with the hope that it may be of use to some one. We also have attempted some general observations in the light of our study and after the experience subsequent to the preparation of the 1915 report.

It was decided at the outset that the period to be forecasted should take in the succeeding 5 years. The Waltham case was much simplified by the fact that the works are not only municipally owned, but that the city has, fortunately, in the main lived up to the principle that its water works are held by it in trust for the people, and has, therefore, given the water takers the benefit of any surplus of receipts over expenditures by reducing the cost of water from time to time to those who pay for and use it. The use of city water for public purposes had for several years been cared for by a charge for all public use of water, except drinking fountains and watering troughs, together with a levy of the nominal sum of $5 annually for each public hydrant.

Supplies for private hydrants and for fire protection purposes have always been furnished free, the owner paying the entire cost of installation. The question of the fairness of this deal from a financial point of view was not considered in the 1915 investigation. It had proved satisfactory to all parties for several years and the fact that the department has never paid taxes to the city pretty nearly evened up the obligation. With this phase of the question eliminated and granted that the consumers ought to receive the full benefit of their co-operative venture, the investigation which covered the 5 years succeeding 1915, and many preceding years as was necessary to help in forecasting the future, was begun along the following lines:

First.—A complete estimate of the reproduction cost of the entire system was made.

Second.—Figures were prepared to show in detail all expenditures for the preceding 5 years, classified and tabulated so as to show their relation to future expenditures. A chart was prepared showing the growth of population in Waltham. Other charts were made showing the quantity and quality of the water from year to year for a long period. The Waltham supply is a ground water taken from 2 large wells near Charles River.

Third.—The effect of metering on revenue and consumption was also especially studied for the preceding 5-year period, as this was a very uncertain element in any estimate of future revenue. Up to 1915 less than 40 per cent of the services were metered.

With all these facts fully investigated and at hand, certain assumptions for the future were made. For one thing it was assumed that metering would be rapidly continued so as to be entirely completed at the end of the 5-year period under consideration, and again that such metering would result in some reduction in the per capita consumption. In 1913 the consumption was 91 gals. per person, with 25 per cent metered, while in 1916 it was 76 gals., with 41 per cent metered. It is believed that this figure should certainly be cut to 65 gals. by the end of the next 5 years.

The next step consisted in forecasting probable future expenditures, both ordinary and extraordinary. In Waltham these consisted of the following: 1. Installation of and repairs to services. 2. Operating expenses, pumping, care of real estate, reservoirs, mains, gates, hydrants, etc. 3. Fixed charges. 4. Extension of metered services. 5. Replacement of mains. 6. Higher service for the higher parts of the city. 7. Additions to the collecting works to provide for a larger supply. 8. Extension of mains.

In order to ascertain how much profit or loss the next 5 years would bring, a careful estimate of income on the basis of existing rates was made. Investigation of past experience seemed to indicate that the income from metered services averaged 90 per cent of what it had been under fixture rates, and this percentage was used as a basis for estimating that portion of the income, as the fixture rate services should be changed over to metered. The remainder of the estimate was comparatively simple. The estimate of income consisted of the following items: 1. Income from fixture rate services. 2. Income from existing metered services. 3. Income from existing fixture rate services changed over to metered. 4. Income from new services. 5. Income from a new high level supply. 6. Income from installation of services, repairs, etc.

The estimate showed a surplus of income over expenses. Definite recommendations were accordingly made looking to a small reduction in income. The reductions were intended to apply to certain charges which the water takers found most annoying as, for instance, an annual charge of 10 per cent of the cost for the meter and its installation in every case. It was also recommended that the city assume the duty of installing supplementary meters in multi-tenement houses, if the owner would arrange the piping so that all meters could be set near together in one cellar. The report was not published until 1916, and its recommendations were not carried out until the year was half gone, so their effects were not very apparent up to the end of the financial year 1916. Work on the extension of the supply has not yet been begun. It proved to be a bigger problem than was anticipated and may cost a large amount of money. All this, together with a large saving in operating expenses, due to a new and businesslike administration of affairs, rather upset the estimates and the department had a larger surplus than was anticipated on Jan. 31 of this year. Just as soon as a definite policy in regard to a more adequate supply can be adopted it is intended to apply the elements of the 1915 study to the new conditions and adjust prices accordingly.

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*Abstract of a paper by Betram Brewer, City Engineer and Superintendent of Water Works and Sewers of Waltham, Mass., presented at the 1917 convention of the New England Water Works Association.

Hydrostatic Tests of 36 In. Submarine Pipe Line

In 1916, as a part of the Catskill water supply system, a siphon was constructed across the Narrows in New York Harbor. This consisted of 9,740 ft. of 36 in. flexible jointed cast iron submarine pipe line with land connections 923 ft. long. The hydrostatic tests, covering 10,300 ft. of this pipe line, including the submarine portion, are described in last annual report of the Board of Water Supply of New York City.

The presence of air trapped in the pipe, which was estimated from data secured during the test as amounting to as much as 20,000 cu. ft., made the measurement of leakage somewhat difficult, but by repeated tests a satisfactory result was obtained. At a pressure of 130 lb. per square inch the leakage for the entire line averaged 5.6 gal. per minute, and at 100 lb. pressure the leakage averaged 1.5 gal. per minute, which is considerably less than is considered allowable for land lines of similar size.

Further proof of the remarkable tightness of this line was furnished between Oct. 21 and Dec. 1, when the pipe was subjected continuously to the service pressures in the Staten Island mains, varying from 100 to 110 lb. per square inch. The water supplied from this service was measured through a small meter placed on a by-pass around a 36-in. line valve. The total average leakage recorded for a period of 40 days, from the 10,300 ft. of pipe under test, was only 0.78 gal. per minute.

In August, the line was flushed out with water from the Brooklyn supply through the blow-off in Staten Island at the foot of Arrietta St. to remove salt water and dirt from the submarine line. Before the flushing, 200 lb. of hypochlorite of lime were put in the pipe on the Brooklyn side. Samples of water were taken and the pipe was found to have been satisfactorily flushed out. Measurements were also taken to determine the flow and the corresponding loss of head. While no very accurate figures could be obtained, an approximate flow of about 19,000,000 gal. per day with a loss of head of about 20 ft. was measured. This corresponds roughly to a co-efficient of 110 in the Chezy formula. The line was again flushed out, using for a short time a flow of about 22,000,000 gal. per day.

Personals

Charles C. Hatline has been appointed city engineer of Frankfort, Ind.

George R. Halpin has resigned his position as superintendent of water works of Watervliet, N. Y.

A. B. Carson, formerly city engineer of Bryan, Tex., has been commissioned a captain in the army.

H. Gordon Hinkle, county engineer of Blair County, Pennsylvania, has been appointed city manager of Altoona, Pa.

W. H. Kirkbride, heretofore division engineer of the Sacramento division of the Southern Pacific R. R., has been appointed assistant superintendent of that division.

W. R. Elliott, formerly chief engineer for the Salt River Valley Water Users' Association of Phoenix, Ariz., has been appointed project manager.

F. G. Ayers, formerly connected with the federal land office at Phoenix, Ariz., has been appointed assistant County Engineer of Maricopa County, Arizona.

James D. Gray, for several years engineer of the state highway department in Mille Lacs County, Minnesota, has been appointed engineer of Federal Aid Project No. 3, calling for a road extending the length of Mille Lacs County.

C. G. Young, for many years well known in the public utility field, has entered the organization of Ford, Bacon & Davis, New York City. Mr. Young will be particularly engaged on reports and appraisals of public utility and industrial properties.

F. H. Williams, city manager of Brownsville, Tex., since the inauguration of the commission-manager form of government two years ago, has resigned on account of ill health. A successor probably will not be named before January.

Joseph M. Bryant has resigned his position as engineer in charge of the Uinta project of the U. S. Indian Irrigation Service and will enter the Navy Department as civil engineer. Albert J. Charles of North Yakima, Wash., succeeds Mr. Bryant.

Calvin W. Hendrick, formerly chief engineer of the city of Baltimore, Md., has been elected president and general manager of the West Virginia Coal & Timber Co., a $600,000 corporation organized recently by Baltimore parties. The new company has bought and will develop 32,000 acres of coal and timber land in West Virginia.

John T. Land, an engineer of Lockwood-Greene Co., has been commissioned a captain in engineers' Reserve Corps. Mr. Land for three years was engineer on the construction of the municipal docks and terminals of the city of Jacksonville, Fla. At the time war was declared he was chief engineer for the Export Railway Co. at Tampa, in charge of its railway terminal and municipal development work, also general manager and chief engineer of the Morey & Thomas Shipbuilding Co.

Charles H. Ewing, heretofore general manager of the Philadelphia & Reading R. R., has been promoted to the office of vice-president. F. M. Falck, who was assistant general manager for some months, succeeds Mr. Ewing as general manager of the road. Mr. Ewing was born at Chester on May 26, 1866, and after graduation from college, entered the services of the Reading, working his way through the engineering department until he was made manager on March 17, 1916. Mr. Falck was formerly superintendent of the Reading Division.

Industrial Notes

Walter A. Zelnicker Supply Co. of St. Louis has just acquired the services of L. B. Moses, who has been closely associated with the rail trade since 1903, when he left the position of assistant to the president of the Kansas City Southern Ry. Since 1911 he has been sales manager of the Kettle River Co. of Minneapolis. Mr. Moses joins the Zelnicker Organization as second vice-president, in charge of the Rail Department, with headquarters at the company's main offices in St. Louis.

L. F. Hamilton, manager Advertising and Specialty Department of the National Tube Co., has accepted a similar position with the Walworth Mfg. Co., Boston, which on Aug. 1, purchased the Kewanee works of the National Tube Co. Mr. Hamilton was born in Kewanee, Ill. He was graduated from the University of Illinois in 1897. He was with the Western Tube Co. until 1908, advancing from claim department and secretary to sales manager. From 1908 to 1917 he was with the National Tube Co. He was identified with the advertising success of the "Kewanee" union, the "Shelby" tubing and the "National" pipe. He has been a contributor to advertising periodicals and speaker on advertising subjects. Several technical advertising men are graduates from National Tube Co. Advertising Department, obtaining their training under Mr. Hamilton, including W. A. Phillis, advertising manager the Borden Co., Warren, O.; Wm. J. S. Ritscher, advertising manager Petroleum Iron Works Co. of Ohio, Sharon, Pa.; G. E. Land, advertising manager Blaw-Knox Co., Pittsburgh, Pa.

The annual salesmen's convention of the Blaw-Knox Co. was held recently in Pittsburgh, Pa. The first day of the convention was devoted to inspection of the "Blaw" plant at Hoboken, Pa., and conferences covering "Blaw" clamshell buckets, "Blawforms" for concrete construction, and "Blaw" fabricated structural steel products. Special train conveyed the entire party the next day to the "Knox" plant at Wheatland, Pa. During the inspection of the plant, and also at the luncheon that followed, L. L. Knox, inventor of water cooled equipment for furnaces, gave a series of very interesting talks on the subjects of water cooled doors, door frames, ports, reversing valves, and other "Knox" products. Additional conferences were held at Hoboken, "Blaw" concrete mixers and "Knox" products being the subjects of discussion. The convention closed with a banquet at the Concordia Club, 110 employes, all directly or indirectly connected with the sales departments, attending. The principal speakers were Messrs. Albert C. Lehman, Irvin F. Lehman, F. M. Bowman, L. L. Knox, Wm. C. Coffin, Benj. L. Hirschfield and Wayne Rawley.

Excavation and Govt. Works
Monthly Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Excavation and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

Volume XLVIII. CHICAGO, ILL., DECEMBER 19, 1917. Number 25.

13½ Bilions for Government Works and Its Significance to Our Readers

Civil engineers and contractors need not worry over the business outlook during the war. They may not secure exactly the kind of work that they have been accustomed to do, but that a tremendous amount of construction will be done is evident. The budget for government expenditures from June 30, 1918 to June 30, 1919, provides $3,504,918,055 for public works. It is stated that a large part of this huge sum will be spent on fortifications. Obviously this will involve vast amounts of earth and rock excavation, and the placing of an enormous yardage of concrete. If this sum is entirely expended in one year, it means an outlay of nearly $10,000,000 a day for public work. To our readers these figures are highly significant. The demand for men trained to design and build engineering works will be unprecedented.

One of our subscribers—a well-known firm of engineers and contractors—was recently awarded a "cost plus" contract for construction in France, the total of which is estimated to exceed $100,000,000. These are the days of big things in the construction world.

Large Purchases of Construction Equipment by U. S. Army Engineers

In our last Excavation and Government Work, monthly issue, Nov. 21, p. 426, we published some astonishing statistics relative to the work already done by the Corps of Engineers, U. S. A. Under two special appropriations $330,000,000 have already been made available for engineering purposes, namely materials and plant to be used in road and railway construction and the like in France. This huge sum will be spent by the engineers before next July. In point of cost it is comparable to the building of the entire Panama Canal in a single year! Among the materials already ordered are enough lumber to make four miles of pontoon bridges, enough ties and rails for 200 miles of track. As stated in another editorial, these engineers will direct the expenditure of $3,500,000,000 on public works in this country—a sum that would build 10 Panama Canals, or 12 times the sum spent last year on roads and bridges in America! These appropriations are so enormous and the construction is to be carried on so rapidly that the demand for civil engineers will be unprecedented before many months have elapsed.

Why Machine Drill Sharpeners Should Be Used More Extensively

For many years machine or power sharpeners have been used at mines, but contractors have been rather slow in adopting machine sharpeners except where a large number of drills were in use. The labor cost of sharpening bits with a machine sharpener averages about one-third the labor cost of hand sharpening (see Gillette's Handbook of Rock Excavation, p. 56, etc.), and the total cost is about half as much for machine work as for hand work. But this is not the only economic advantage, for machine sharpened bits require less frequent sharpening and the drilling speed is often 15 per cent greater than where hand-sharpened bits are used. A machine operated by one man can repoint 60 bits an hour, and the bits are perfectly uniform. Even where there are so few drills that a drill sharpening machine cannot be kept busy, it pays to own one.

Use Bolts Instead of Spikes on Temporary Timber Work

In building falsework, forms and other temporary wooden structures it has usually been the practice to use spikes and nails freely. The high price of lumber is now leading to the substitution of bolts for spikes wherever practicable, so that the salvage value of the material may be increased. Bolts would be more frequently used were a compressed air auger and portable air compressor at hand. There are so many uses to which compressed air tools can be put that it is surprising to note how few contractors have a small air compressor as part of their equipment.

Will Railway Construction Be Backed With Government Credit?

Eastern railways are congested with freight to such an extent that many passenger trains have already been discontinued. The congestion is mainly due to lack of trackage, both in main lines and yards. It has been said that another four-track line from New York to Washington is badly needed. Certainly more trackage is required between New York and Chicago.

On new construction work alone a billion dollars can be effectively invested by American railways every year for ten years to come. But railway credit is so poor that the money can not be raised without government assistance of some sort. If the assistance comes only in the form of higher freight rates, it may be doubted whether the public will buy new issues of railway stocks until there is further government aid to railway companies. It begins to be evident that the government must not only raise railway rates, but lend money to the railways. If, as seems likely, a billion dollars should be loaned next year to the railways by the government, railway contractors will experience the busiest year of their lives.

The Cost of Hydraulicking a Small Yardage of Earth

The question frequently arises as to whether it will be economic to excavate a small quantity of earth by the hydraulic method. Hence cost data on installing and operating a small sluicing plant are particularly useful. The following data relate to the sluicing 2,750 cu. yd. of clay into the main canal of the Grand Valley irrigation project, Colorado, the work being done by the U. S. Reclamation Service:

	Per cu. yd. Ct.
Repairing and installing plant ($185)	6.7
Labor operating plant	3.9
Material for operating	0.1
Power, 1.92 K. W. H. at 3.53 ct.	6.8
Removing plant ($101)	3.7
Total	21.2
Engineering, automobile expense, etc.	7.9
	29.1

The item of repairing and installing plant consisted largely of initial repairs to an old pump before putting it in service. An electric transmission line already existed, so that there was no expense involved in building a power line.

A hydraulic giant, 40 ft. of riveted pipe and 75 ft. of 6-in. canvas hose, cost $146, but as they were in actual operation only 84 hrs. the depreciation was nominal. A two-stage centrifugal pump with a 6-in. discharge, driven by a 75 H.P. motor, delivered 3.13 sec. ft. With a 3½-in. nozzle the giant could throw the water 110 ft. horizontally.

Two men operated the plant. The material excavated was a dense, tough clay. The stream from the giant was kept moving over the face of the bank, to remove the clay in thin layers so that it would sluice readily. A short wooden flume delivered the material into the canal whose porous sides it was desired to silt up with the clay. There was pumped 340 cu. ft. of water for every cubic yard of clay. The rate of excavation was 33 cu. yd. per hour for 48 hrs. of actual operation. This is a low rate, but the clay was tough and it was desired to reduce it to a very fine mud that would be carried in suspension for a long distance in the canal.

How to Snatch Wagons Out of a Pit Rapidly

So simple a problem as snatching loaded wagons out of a pit will often repay careful study. Thus one frequently sees two snatch teams at work where one hoisting engine would do the work and with less strain on the wagon teams. In order to speed up the work, it is frequently possible to provide two roadways out of the pit, the roadways meeting on the level ground. Between the Y formed by the two roads, a hoisting engine is placed, and on the level ground near the junction of the two roads a deadman and a swiveling sheave are placed. The cable from the engine passes through the sheave, and its free end is hooked to the rear end of an empty wagon as it descends into the pit. Then it is hooked to a loaded wagon which is pulled out. The next empty wagon descends on the other roadway, and thus the wagons descend and ascend alternately on the two roads. A wagon every minute can thus be snatched out of the pit by the hoisting engine.

The Extent to Which Government Work Is Subcontracted

When a large government contract is awarded to one company the public is apt to say: "Lucky dog." The fact is that not one but perhaps a hundred "lucky dog" companies are involved in the execution of the one contract. For example, the Crane Co. of Chicago received a contract to furnish all the sanitary and piping equipment for the 16 army cantonments. Within three months all the material had been delivered and 90 different companies had furnished material to the Crane Co. under its contract with the government. These 90 companies were virtually sub-contractors. The government is to spend more than $3,500,000,000 on public works next year. Doubtless a good many very large contracts will be awarded, but under each of the contractors there will be a great many sub-contractors.

Count the Idle Men in a Job Periodically

If you wish to realize fully the amount of lost time on a job, count the men who are temporarily idle once every minute for a quarter of an hour. Thus at 9:30 you may note that 3 men of a gang of 8 are not doing useful work; and, again, at 9:31 you may note that 4 men are idle. An average of 15 counts (one every minute) discloses, say that 40 per cent of the men were idle at the moments the counts were made. Several such counts made during a day will frequently act as an eye opener, and lead to changes of methods and organization. An interesting article on "Why Some Contractors Fail to Make Money," in our Nov. 21 issue, contained an illustration of the application of this method.

The Miami Flood Protection Work to be Done by Day Labor Directed by a Contractor

It has been decided to reject all bids, except for one minor part, on the Miami Valley, Ohio, flood prevention work, which will cost about $25,000,000, and to do the work by day labor. Charles H. Locher of Bristol, Va., has been selected to organize and direct the construction forces. Mr. Locher is one of the ablest contractors in America. In addition to being an executive he is an inventor. Some 25 years ago he invented an aerial dumping device for use on cableways that removed rock and earth from the Chicago Main Drainage Canal. Gillette's Handbook of Rock Excavation, p. 653, says: "This device insured the success of the cableway."

On a contract for excavation of rock for a new channel at Sault Ste. Marie, Mr. Locher devised a cofferdam that made it unnecessary to remove the rock by subaqueous methods, although the Government engineers had regarded it as impracticable to do the work "in the dry."

Mr. Locher has been a member of several contracting firms that have executed important contracts, such as the Shoshone Dam, the Wachusett Dam, work on the Chicago Drainage Canal, the New York Barge Canal, the Catskill Aqueduct, etc.

The engineering of the Miami flood protection project is in the hands of an able corps of engineers under the leadership of Arthur E. Morgan. With Mr. Morgan as chief engineer and Mr. Locher as chief constructor, this great project will be handled expeditiously and economically.

How You Can Assist in Recruiting the Quarrymen's Regiment

A special Quarrymen's Regiment—the 28th Engineers—is being recruited for service in France. Read the advertisement in this issue and assist your government in securing recruits. There are 18 different classes of skilled workmen needed, as listed in the advertisement, which also gives the rates of wages paid. Among the men who are working for you or whom you know, there are doubtless some who are qualified to join this regiment, and who would gladly go. Either post this advertisement where they will see it, or mail it to some one who is likely to be influenced by this call to serve the nation in its hour of need.

Lubricating an Earth Chute with Water

Where earth is to be moved a comparatively short distance by gravity, and where there is no objection to converting it into mud, it is frequently economic to chute it down a steel-lined trough. In such a case the trough may be lubricated with water from a 1 to 1½-inch perforated pipe laid along the bottom of the chute.

If muddy earth is fed from a bin into a chute, it may clog the bin gate. In this case a steam pipe can be used to make the mud flow out, by shoving the pipe down through the mud from the top and turning on the steam.

We have never heard of the use of a concrete tower and chute for conveying earth, but it is apparent that if the earth were converted into a thin mud it would be feasible to move it a considerable distance in this manner.

Enlistments For the Road Battalions of the Sawmill Regiment (20th Engineers) Are Desired

We are in receipt of a telegram from Capt. H. L. Bowlby stating that three road-building battalions of 1,000 men each are to be enlisted as part of the Sawmill Regiment, the 20th Engineers. Our readers should not confuse these battalions with those of the Road Building Regiment—the 23d Engineers.

Capt. Bowlby's telegram is as follows:

> War Department has authorized three battalions of 1,000 men each to build roads and bridges with the Twentieth Engineers, the large Sawmill Regiment. The three battalions are being raised at Camp American University, Washington, D. C., by Col. W. A. Mitchell of the Twentieth Engineers. Their work in France will consist of laying out logging and sawmill camp sites and constructing and maintaining roads and bridges from the woods to the mills and from the mills to the distributing depots. Road foremen, quarrymen, rollermen, stationary engineermen, concrete foremen, bituminous plant and construction foremen, machinists, carpenters, asphalt workers, skilled and unskilled road and bridge labor of all kinds are desired. Enlist at any recruit office for the Twentieth Engineers' Road Section. Further information can be obtained by addressing Colonel Mitchell, Camp American University, Washington, D. C.

Pulling Trench Sheeting With a Backfiller

The scarcity of labor is leading to the more extensive use of small power scrapers for backfilling trenches. It is not generally realized by contractors that a backfiller can also be used for pulling the sheeting from a trench after it has been filled. To do this a tripod, with legs 12 to 14 ft. long, is set over the trench and provided with a snatch block through which passes the hauling line from the backfiller to the sheeting timber to be pulled. The operator of the backfiller, aided by one man, can readily pull 16 sheeting 12-ft. planks per hour.

Flood Concrete to Protect It From Freezing

Concrete is frequently used to line ditches or in other places where it is feasible to cover it completely with water soon after it is laid. Water can then be used to protect the concrete from freezing. Although there is no record of its having been done, it would seem practicable to protect a concrete road or pavement base in this manner, for small earth dikes could be built to hold the water.

Boring Blast Holes in Frozen Earth

When it is necessary to blast frozen earth, bore holes can be readly put down with a hot hand drill. In some cases the drill steel is solid and is well heated at the lower end, which facilitates its penetration when driven into the earth. In other cases a hollow pipe is provided with a steel cutting bit, and the bit is kept hot by steam escaping from perforations in the pipe just above the bit.

Would it not be feasible to fill such a hollow drill with boiling water, and thus use it to churn a hole into the frozen earth?

Use Automobile Horns Instead of Bells For Signalling

From time immemorial bells have been used for signalling on construction work; but a bell is not particularly loud and is often not audible unless very close to the man who is receiving the signal. On the other hand a Klaxon horn can be clearly heard a long way off, hence it may be used to signal to an operator, or to call a superintendent to a telephone, or to announce the dinner hour, and the like.

Mounting of Hammer Drills on Tripods

To the Editor: In your issue of Nov. 21, page 409, I note an editorial entitled, "Why Are Air Hammer Drills Not Mounted More Commonly on Tripods?"

The suggestions contained in this editorial seem to me to be rather dangerous and are very apt to invite trouble. The modern hammer drill used for down hole work, unlike the reciprocating drill, is of very light construction, weighing not to exceed 40 lb. to 60 lb. A suitable tripod would weigh in the neighborhood of 150 lb. to 200 lb. or from three to four times as much as the drilling machine. The drill used without a tripod requires no helper, whereas mounted on a tripod a helper would have to be provided in order to handle the heavy mounting. There is no real excuse for mounting a 40-lb. machine, as most of them are self-rotating, and the only effort required on the part of the operator is in holding the machine to its work when starting a hole and in changing drill steels, which work would not be eliminated by the use of a tripod. This is irrespective of the depth of the hole.

You refer particularly to the application of a tripod and hammer drill to work in seamy ground. It seems to me the objections to the use of this type of equipment are even more pronounced than under other conditions, as the drilling machine would necessarily be in fixed position, and the tendency of the drill bit to follow a cleavage would put an enormous strain on a comparatively light drilling machine. I am afraid this would lead to all sorts of trouble.

There is another objection to a tripod mounting, and that is the time lost in moving the mounting and readjusting the machine from hole to hole would materially reduce the actual drilling time, materially increasing the cost of drilling per foot of hole. It is not uncommon to find an unmounted hammer drill will put down a reasonable depth hole in the time ordinarily required to move a tripod and reciprocating rock drill.

C. A. Hirschberg,
Publicity Manager, Ingersoll-Rand Co.,
New York.

[The editorial suggestion in our issue of Nov. 21 was prompted by the fact that 40-lb. hammer drills are being successfully used on quarry bars and tripods in two quarries of the Knoxville, Tenn., marble district. The Appalachian Marble Co., for example, has displaced 6 piston drills with 4 air hammer drills (40-lb.), and only 5 men are needed to operate the 4 hammer drills as against 12 men formerly required on the 6 piston drills. Hammer drills are mounted in pairs on a quarry bar 10 ft. long. Drill holes are 14 ft. deep and 1½ in. diameter at the top 1 1/16 in. at the bottom. The holes are close spaced, which enables the drilling of several holes from one setting of the quarry bar. In our next Excavation issue we hope to have some data relative to the use of these hammer drills on tripods.—Editor.]

How the $150,000,000 Cantonment Construction Program Was Handled

The Cantonment Construction Division, an organization which did not exist 6 months ago, has built in this incredibly short period of time 16 National Army cantonments, with 26,500 buildings to house and care for 675,000 men; two embarkation camps for 43,000 men; one quartermasters' training camp for 18,000; additions to the regular army barracks, for 100,000; repair shop units; the semi-permanent structures at 16 National Guard camps, to care for 462,000 men, and has designed and purchased equipment for certain large plants for our army in France—a tremendous task involving 200,000 men, and an estimated cost of approximately $187,000,000, over three-fourths of which has already been spent. In his address delivered Dec. 5 before the American Society of Mechanical Engineers, an abstract of which is given below, Mr. Leonard Metcalf of Metcalf & Eddy, Consulting Engineers, Boston, Mass., summarizes the splendid achievement as follows:

"Where can you duplicate the experience, involving as it does an expenditure of $150,000,000, in 6 months' time, three times the maximum rate of expenditure in 12 months on the Panama Canal, and which increased 10-fold the normal building activities of the country, without substantial increase in the cost of materials from beginning to end of the task—due largely to the work of the War Munitions Board of the Council of National Defense and its committees; involving meager compensation to the administrators, designers and supervisors and voluntary service on the part of many skilled advisers, who dropped important personal obligations to go to Washington for days, weeks or months in response to telegrams asking for help; voluntary co-operation and work by the railroads, telephone, electric and other utilities, and substantial expenditure without guaranty of return; contractors taking contracts to build structures estimated to cost from $3,000,000 to $4,000,000 and actually building these and many additional structures so that the final contract sums ranged from $8,000,000 to $10,000,000 per cantonment, nearly doubling the necessary construction period, but without increase in compensation, and this when the compensation upon the building of the National Army cantonments was limited, not to a profit of 10 per cent, as has so often been stated, but to a gross return of $250,000, averaging for the 16 cantonments less than 3 per cent, out of which sum had to come an overhead expense of probably $100,000 and interest charges upon $600,000 to $1,000,000 of working capital amounting to perhaps $25,000 to $40,000 more, leaving a net profit to the contractor of substantially less than 2 per cent."

On May 17, 1917, Brigadier General I. W. Littell, then colonel of the U. S. Quartermaster Corps, was detailed by the Secretary of War to assemble and direct an organization to be known as the Cantonment Division of the Quartermaster Corps, to provide facilities for training and housing the new National Army and National Guard. He called to his aid Major, then Captain, W. H. Oury, Major, then Captain, R. C. Marshall—both of the regular army—and Major Dempsey of the Officers' Reserve Corps, the former of whom had been supervising the enlargement of some of the army barracks, the second of whom was soon engrossed in the new cantonment construction, and the last of whom took up the question of auditing construction expenditures.

Neither funds nor quarters nor personnel were available for the designated service, for the appropriation bill which carried $77,000,000 for the inception of this work, was still in debate in Congress. This was the opportunity of the Committee on Emergency Construction of Buildings and Engineering Structures of the War Munitions Board of the Council of National Defense. Of the latter board Frank M. Scott of Cleveland was the able chairman. This committee was made up of five experienced builders—William A. Starrett of New York City, architect and formerly of the building firm of Thompson-Starrett Co., chairman; C. W. Lundoff of Cleveland, president of the Crowell, Lundoff, Little Co., building contractors; M. C. Tuttle of Boston, general manager of the Aberthaw Construction Co.; Capt. Wm. Kelly of the U. S. Engineer Corps, who, however, was unable to give much time to the work of the committee, owing to other army obligations; and Frederick Law Olmstead of Boston, engineer and landscape architect. To their assistance they called many engineers, city planners, architects and specialists of different kinds, to act on sub-committees or to give desired advice on special subjects.

Circumstances thus made it possible for the committee to render General Littell service in an advisory capacity on the formation and civilian personnel of his organization, on the form of contract under which the work should be built, on engineers, city planners and contractors of responsibility to design and build the cantonments, and at the moment to make the most of the time which might elapse before the appropriation bill should be passed by Congress, by preparing typical plans or layouts for the buildings and other structures involved, making topographic plans of the sites, studying the water supply, sewerage and other public service facilities, the best arrangement or grouping of structures, adapting the typical plans to the local topography—all through the voluntary service of architects, engineers and city planners.

The organization proposed by the committee and adopted by General Littell comprised four different groups, reporting to his staff officers:

Major Frank M. Gunby, formerly associated with Charles T. Main of Boston, in charge of design; assisted by Major F. B. Wheaton, Capt. Doten, Dabney H. Maury, Clarence Goldsmith and W. M. Johnson of the National Board of Fire Underwriters, and George Gibbs, Jr., of Boston.

Major Robert E. Hamilton, formerly purchasing agent of Stone & Webster, in charge of materials and transportation.

Major M. J. Whitson of Seattle, formerly partner of Grant, Smith & Co., in charge of construction; assisted by a staff of division engineers—Peter Junkerfelt, Charles L. Paralee, Ezra B. Whitman and others.

Major Dempsey in charge of accounting.

Since that time, benefiting by the earlier experience and with a view to handling the additional work of building ports of embarkation, ordnance depots, coast artillery posts, medical department construction, mobile ordnance school barracks, quartermasters' warehouses and miscellaneous plants, the organization has been enlarged, modified and strengthened, Major Marshall remaining in command under General Littell, assisted by Captains Thompson and Maupin; the engineering branch being still in charge of Major Gunby; the construction of Majors Whitson and Junkerfelt; the materials of Major Willcutt; finance and accounting of Major Dempsey; construction and repair of Major Zollars; the law, Major Shelby; information, Capt. Erek; transportation requisitions, Capt. Ritche and Chief Clerk Moreland; and several other engineers of large reputation and breadth of experience, such as Lincoln Bush, Major Betts, Warren R. Roberts, and others, have been drawn into the service, fine examples of personal sacrifice.

The Committee on Emergency Construction of Buildings and Engineering Structures first undertook to get local investigations under way and the preparation of typical building plans. As soon as cantonment or camp sites, were designated by the department commanders, approved by the army staff and reported to General Littell, city planners and consulting engineers, were asked to go to them, voluntarily and at their own expense, to make topographic maps, study the water supply and sewage disposal problems, the location of railroads, roads and other utilities, and to report to Washington with all dispatch. Within a week's time in a number of cases, topographic maps were prepared of areas of from 1,000 to 2,000 acres, and essential information was obtained upon the points desired. Meanwhile, leading architects and engineers, had been summoned to Washington to assist in the revision of the plans for the barracks, the preparation of typical plans, which were afterwards adapted to the local topography, on the ground, by the staffs sent to the individual camps.

Meanwhile, contractors were assembling in Washington to see if they could be of service and the committee directed its efforts to the preparation of a form of contract under which a work, of the magnitude then contemplated and since largely increased, could be built with reasonable certainty within a time-limit of 90 days, in the face of congested transportation conditions, soaring material prices and labor shortage.

A form of contract inducing speed was essential. This compelled the elimination of the financial hazard to the contractor, and for the protection of the Government the selection of contractors solely on the basis of experience, merit and integrity. It was at once apparent that the competitive form of contract dictated by past Government precedent, was out of the question with the time limit available and the conditions to be faced.

Lump-sum-profit basis form of contract was weighed and rejected as likely to emphasize the idea of barter and trade rather than of fitness and competency, and to embarrass the Government in awarding contracts to more experienced contractors if lower profit basis were offered to the Government by less experienced or desirable men.

The cost-plus-percentage basis, however, appeared to meet the fundamental requisites and the addition of a limiting lump sum profit made the Government safe in its operation in the event of substantial increase in the amount of work done under it. The combined efforts of many able men—lawyers, engineers and contractors, as well as of various engineering organizations, produced the "Emergency Construction Contract"—a radical departure from Government precedent—which provided essentially for the construction of the work on the basis of cost, plus profit, the latter varying from 10 to 6 per cent, with the magnitude of the work, with the important limitation of an upset profit of $250,000, from which sum, however, the contractor had to meet his own office overhead and interest costs. It is interesting and but fair, in the face of some of the unfounded public criticism which has been heard, to note the effect of this upset limit of profit. On the construction of the 16 army cantonments, involving a total cost of approximately $134,000,000 or upwards of $8,000,000 per cantonment, the nominal profit to the contractors will be less than 3 per cent and after deducting the probable contractor's overhead and interest costs, the actual profit substantially less than 2 per cent—in some cases perhaps less than 1½ per cent. Upon the construction of the National Guard camps, involving a total cost of $36,000,000, or about $2,250,000 per cantonment, the contractor's fee is higher, approximately 7 per cent—but as the overhead cost is also proportionately much higher the total return in cash for the six months' period of work is substantially less than in the cantonment construction.

Inasmuch as nearly all of the war construction work now being executed by the Government is being done on an emergency basis, where speed and not cost must control, thinking men will be careful not to criticise carelessly and will weigh fairly the influence of the time element. In the execution of work on such a tremendous scale, under prevailing labor and material cost conditions, it is inevitable that money will be wasted and mistakes made, but the work must be done—expeditiously done—that the saving may be one of lives and days, not dollars.

While the preliminary investigations were under way, the committee sent out questionnaires concerning contracting firms in this country, seeking references, a statement of the magnitude and kind of work executed during the past 2 years, the number of men handled and fed at one time, and the financial resources of the concern; obtained the rating of the contractors by important financial-credit concerns, and called to its assistance John H. McGibbons, formerly of the U. S. Fidelity & Guaranty Co. of Chicago, to aid it with his broad knowledge of the standing and financial credit of contractors.

Armed with this information a sub-committee of five men, with Mr. Starrett as chairman, selected the contractors deemed best qualified at the moment to undertake the work and who had demonstrated in their past experience their ability to handle work of such a character and upon such a scale; and reported its findings to Mr. Scott's committee of the War Munitions Board. From the latter committee, recommendation passed to General Littell, and after submission of the evidence and recommendations to the Secretary of War, appointment was finally made by General Littell. The subsequent experience in the building of the camps seems clearly to have justified the course of procedure, and it is greatly to the credit of the Government that it can be said, unequivocally and with absolute candor, that these appointments were made on the merits of the case, as they were understood, without political pressure or "influence." It is further greatly to the credit of the leading firms of contractors that as a rule their representatives left Washington before they knew whether they were to be recommended for specific work and before appointment were made.

The committee then turned its attention to the preparation of forms of contract for the employment during construction of the engineers and other experts necessary at the camp sites, being greatly assisted in its work by different members of the national engineering societies, who voluntarily came to Washington in response to telegraphic request to assist the committee.

Engineers believed to be most competent and at the moment available for service at the various cantonments, were also designated—appointments in all cases being made, of course, by General Littell and his staff.

In this way the Government had the voluntary service of many men—skilled in the particular field involved—in building up an effective organization and personnel for the work in hand; men who co-operated in a thoroughly disinterested way with the administrative army board, in responsible control. The results attained here seem to indicate the advantage of such a purely advisory board, the recommendations of which could be followed, modified or rejected with cause, by the duly-constituted executive authorities.

The 16 national army cantonment sites were approved at various dates ranging from May 31 to June 27, 1917, contracts for their construction were executed between June 15 and June 23, and work was begun between June 13 and July 6. On Sept. 4, or in less than three months' time, about 430,000 men could have been taken care of at the cantonments, on the first adopted basis of 200 men to the barrack, later reduced to 150 men, and on Dec. 5, 1917, the camps were substantially all completed, despite the great increase in construction involved by the prescribed increase in cubical air space per man in the barracks, from 365 to 500 cu. ft., the addition of remount stations, to care for 10,000 horses at each of the camps having them, hospitals and other changes, which have nearly doubled the work originally contemplated.

The story of the construction of the National Guard camp equipment is similar, except that the work involved is only about one-fourth of that involved in the construction of the cantonments.

A few figures in regard to the magnitude of the work involved in building the 16 National Army Cantonments may be suggestive. There were required upwards of 800 billion feet, or 37,000 cars of lumber, and 40,000 cars of other material—a total of 77,000 cars upon the cantonment construction without allowance for the materials ordered locally and not from Washington, the total involved in the cantonment, camp, and embarkation station construction to Oct. 31, being approximately 112,000 cars; 756,000 squares of sheathing paper, 800,000 of roofing paper, 172,000 doors, 34,000,000 sq. ft. of wall board, 106,000 kegs of nails, 314,000 barrels of cement, 282 miles of wood and cast iron pipe, 3,550 hydrants, 75 miles of fire hose.

As the construction of the cantonments was drawing to an end the work of this bureau was extended to cover the construction activities of the army—except in a few special cases such as in the aviation corps, where it was thought wiser by the Secretary of War to leave the construction in the hands of the departments for the use of which the structures were to be built. This new work is well under way, constantly growing and broadening.

As one reviews the work accomplished by this Cantonment Division, one cannot but be thrilled by this fresh evidence of the resources of these United States and the loyalty and ability of its people—remembering how recently and in what manner this bureau was organized; that cantonment construction involved but one branch of governmental activity and one comparatively small group of men, and that similarly inspiring evidences of effective service are to be found in all of its other branches.

Method and Cost of Clearing Cut Over Land With Powder

Under a co-operative plan with the Land Department of the Potlatch Lumber Co. the Forestry Department of the University of Idaho has been carrying out extensive land clearing operations with a view of determining the most efficient methods. The results obtained in this work by the use of blasting powder are described in a recent bulletin of the University Agricultural Experiment Station, from which the matter following is taken.

The site selected for the operations was on level bottom land in the valley of the Palouse River, Idaho. The soil is classified by the U. S. Bureau of Soils as "potlatch silty clay loam with a tendency to be clayey." The soil was underlaid with a hardpan formation at an average depth of about 3½ ft. It had been covered formerly with a dense stand of western yellow pine, Douglas fir and western larch, in approximately equal proportions as shown in the following table:

PERCENTAGE OF TIMBER.
(Ft. diameter.)

Plot No.	Red fir	Yellow pine.	Tamarack.
1	35.7	30.5	34.7
2	49.3	23	27.7

Some of the pine had been cut 8 years. Most of the tamarack and fir had been logged more recently; some only 2 years before. All except the smaller stumps were sound.

Two working plots each of 5 acres were carefully selected with the view of securing representative cost figures. Each plot was handled in exactly the same manner as regards preliminary work, the making of holes, piling and burning logs, brush and stumps, and leveling the ground after all clearing work had been done. The explosive used in Plot No. 1 was a 20 per cent stumping powder; on Plot No. 2 a potassium chlorate powder equivalent to 60 per cent dynamite was employed.

The number and per cent of sound stumps in each plot were as follows:

NUMBER AND PER CENT OF SOUND STUMPS.

	Plot No. 1		Plot No. 2	
Diameter.	Feet diam	Per cent.	Feet diam.	Per cent.
6-in	26	5	4	1
8-in	12.8	2.4	7.8	1.7
10-in	19.1	3.7	12.5	2.8
12-in	3.1	6	2.0	4.7
14-in	22.2	4.2	11.8	2.4
16-in	38.8	7.1	40	9
18-in	28.5	5.4	28.5	6.4
20-in	18.4	9	26.6	6
22-in	57	11	55	12
24-in	46	8.4	24	5.4
26-in	39	7.3	32.5	8
28-in	30.4	5.7	21	4.8
30-in	12.5	2.3	17.5	4
32-in	21.4	4	26.7	6
34-in	14.1	2.6	21.6	4.8
36-in	24	4.5	15	3.4
38-in	12.6	2.3	12.6	2.8
40-in	6.7	1.2	6.7	1.5
42-in	10.5	2	14	3.1
44-in	18.3	3.4	29.3	6.6
48-in	8	1.5	8	1.8
56-in	4.6	0.7	9.3	2.1

A crew of from 4 to 6 men was used for the work of swamping and sawing, while two men with teams worked to best advantage after the material was cut up and rolled out where it was easily accessible. The large logs were thrown into heaps and constituted the base of all the piles. The lighter logs with limbs, brush and stump fragments were then thrown on top, completing the work preparatory to burning. The tools used were the axe, the cross-cut saw, canthooks, mattocks, shovels, augers, block and tackle, ⅝-in. wire cable, a snatch block open at the side to admit cable without passing the end through the block (a very great advantage), and a digger with a 3-in. cylindrical bit open on one side and welded to an 8-ft. handle of 1-in. gas pipe, which is an excellent tool, capable of cutting its way through roots and frozen ground. A battery costing about $18 with lead wires completed the outfit of tools.

Swamping, Sawing and Piling Logs, Brush, Etc.—The preliminary work consisted of swamping and sawing and placing all brush and unsound logs, limbs, brush, etc., in piles for burning. The cost of the preliminary work was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate.	Total.	Hours.	Rate.	Total.
Swampers	176	$0.25	$44.00	135	$0.25	$33.75
Sawyers	39	.25	9.75	44	.25	11.00
Teamsters	40	.25	10.00	19	.25	4.75
Teams	40	1.00*	4.45	19	1.00*	2.10
Feed	..	1.00*	4.45	...	1.00*	2.10
Total			$72.65			$73.70
Per acre			14.53			14.74

*Per day.

Locating and Making the Holes.—One should have a good knowledge of the root system of the different species before undertaking this part of the work. Nothing is of more importance than determining upon the position, number, and depth of holes to be made under the large stumps. The exercise of proper judgment on these points will do more than anything else to reduce the amount of powder used and to secure the highest possible efficiency.

General View of Plot No. 1 Before Clearing Was Started.

View Across Plot No. 2 Showing Conditions Before Work Was Begun.

Large yellow pines generally have large, strong, and heavy tap roots. White pine and Douglas fir, as a rule have no tap roots, but have large spreading laterals that are fairly easy to lift with properly placed powder. Larch roots are mostly lateral, but enter the ground obliquely and are hard to remove. Holes should run well toward the center in yellow pine, intermediate for larch, and well toward the periphery of the base of the stump between the large laterals for large firs and white pine.

Various species tend to develop stronger tap roots on sloping, well-drained and aerated soils, than on level or mucky soils or in swamps. The laterals tend to be more oblique when growing under the former conditions than under the latter. These are important general rules which hold good for all species.

The number of holes to be placed under a stump in order to remove it completely and yet not waste powder was a point which received the most careful attention. One hole was found to be sufficient for removing stumps up to 18 in. in diameter, while two holes were sufficient for removing stumps up to 30 in. in diameter, and three holes for 40-in. stumps. Four holes were generally found ample for removing larger stumps, though for the largest five holes were sometimes found necessary.

The depth of the holes is also a very important feature and the success or failure of any blast often depends as much on the depth as on the location of the holes.

It was suggested that the vertical depth of the hole should equal the diameter of the stump. This rule was found to work well until the diameter of the stump exceeded 4 ft. It seemed that the sinking of the holes to a greater depth was of doubtful utility, at least for the soil conditions found on these two tracts.

Method of Piling Stumps and Logs Preparatory to Burning.

In order to insure the perfect removal of the laterals it was found necessary to rupture an area of soil having a radius about three times greater than that of the stump, and in going deeper than 4 ft. the weight of the earth to be removed is so great as to yield unsatisfactory results. It was found, therefore, to be impracticable to go deeper than 4 ft. No more earth should be removed than is necessary in order to secure efficiency on account of the added expense of filling the holes. Holes should be deeper in sandy or dry, loose soil, and shallower where the hardpan is near the surface or where the ground is moist or well frozen on top.

The cost of making the holes for the powder was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate	Total.	Hours.	Rate.	Total.
Boring holes	152	$0 25	$38.90	168	$0.25	$42.00
Per acre			7.78			8.40

Placing the Powder.—In loading the holes great care should be exercised relative to the proper amount of powder to be used under the stump and also to its proper distribution in the case of the larger stumps. Here again the powder man must study the root-system and the slope and be guided accordingly. He must strive to place the powder in the various holes in proportion to the amount of work to be done in each place. The proper way to put a charge of dynamite into a hole is to split the cartridges down the side and cut them in two. This puts the powder into a small, compact space. The cap should be put into the end of a half unsplit stick, which should be placed well down in the charge in the hole. If electric fuses are to be used, a half hitch around the end of the cartridge is desirable in order that the cap may not be pulled out in tamping the powder and adjusting the wires. This tamping should be done firmly but very carefully with a wooden tamping stick until the charge is covered to a depth of 5 or 6 in. The earth used in filling the remainder of the hole should be very firmly tamped, as the efficiency of the powder in a properly tamped charge may be nearly double that of one tamped in a loose and careless manner. One should remember that the force of the explosive depends more on the degree of confinement than on any other single factor, and any crevices or air spaces greatly reduce the power of the explosive; for this reason water is the best possible confining medium, but cannot be recommended for general use, since it is often not conveniently at hand. Waterproof fuse must be used in tamping with water and great care must be exercised to render the caps watertight around the fuse, by means of soap, tallow, or some other sealing medium.

When more than one charge is to be used under a stump, it is highly desirable to fire by means of electric fuses and a battery. This is because of the fact that it is nearly impossible in using the ordinary time-fuses to bring about all the explosions at the same instant. Since the efficiency of the powder and likewise the work, depends in a great measure on this one factor, it should not be neglected. Where one charge explodes before the others, its energy is expended in loosening the soil without removing the stump and the effectiveness of the other charges is thus greatly reduced, whereas if all are exploded at once each has equal lifting power because of the proper conditions of soil firmness under which each does its work.

Where only one hole is used in removing the stump it is cheaper to use blasting caps rather than electric fuse, and is usually as effective. This is true unless the stumps are so close together that the ground around others will be loosened. In such cases a battery should be used and the entireg roup fired at once.

The labor cost of the blasting was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate.	Total.	Hours.	Rate.	Total.
Powderman	58	$0.35	$20.20	41	$0.35	$14.35
Helper	58	.25	14.50	68	.25	17.00
Total			$34.70			$31.35
Per acre.........			6.94			6.27

Strength of Caps.—The lower the strength of powder the greater the strength of cap necessary to secure the greatest efficiency. This had been definitely determined by the United States War Department. Many persons make the serious mistake of using low-power caps because they are cheap. The War Department has shown that 40 per cent dynamite is 15 per cent stronger when a No. 5 cap is used than when a No. 3 cap is used; while the difference is only 6 per cent when 60 per cent dynamite is used. When several stumps stand together, electric fuses and a battery should be used, the stumps being connected in a series.

Quantity of Powder to Use.—Great care was used to determine just the proper amount of powder necessary for different sizes and species of stumps. In general one should so strive to place the charges under a stump, both in position and amount, as to exert a pressure under each main division of it sufficient to just throw the stump out of the ground. Either a larger or a smaller charge is wasteful. The use of an insufficient amount of powder cracks the stump and so loosens the soil as to make the final removal with powder costly. When a second blast is necessary more powder is often required to remove the shattered stump than would have been necessary to have completely removed the stump in the first attempt. For this reason it is always better to use a slight excess of powder as a factor of safety, thus insuring the removal of the stump at the first trial.

Since the efficiency of powder varies with the varying conditions of soil, moisture, stumps, etc., this problem must be worked out in a general way for each locality. A little careful study and experimentation in starting work in a new field will save much powder, time and labor.

Piling and Burning the Stumps.—In piling the stumps four men were found necessary with each team in order to secure the greatest efficiency. All the loose fragments were drawn to the log heaps and piled as high as possible by hand; sometimes separate piles of stumps alone were made when this was most convenient. A ginpole was not used as it was thought that by being careful to bring the larger fragments to the piles at first and while they were low, nothing would be gained by using the pole. Hanging fragments were removed occasionally with a second blast, but generally by means of the team and single block and cable. Occasionally two double blocks and a ⅞-in. wire cable were also brought into action, the single block being attached to the running end of the large cable from the double blocks. This arrangement proved to be very efficient, multiplying the power of the team approximately six times.

At first a few piles were made around large shattered stumps in the hope of removing them by means of fire, but this was found to be expensive and unsatisfactory, as the piles were consumed long before the stumps were burned out, and much labor and trouble were necessary in keeping the fires going till the stumps were consumed. In burning it was found best to fire first a pile of stumps and logs here and there. This gave abundant live coals for readily kindling the remaining piles and proved a great saving of time. One man with a long-handled shovel could quickly have all the rest burning. As the piles burned out it was necesary to throw the material from the outer edges into the center, until all was consumed and the ground thus left ready for leveling.

The cost of piling the stumps was as follows:

	Plot No. 1			Plot No. 2		
	Hours.	Rate.	Total.	Hours.	Rate.	Total.
Swampers	168	$0.25	$42.00	220	$0.25	$55.00
Teamsters	42	.25	10.50	52	.25	13.00
Teams	42	1.00*	4.65	52	1.00*	5.80
Feed	...	1.00*	4.65	...	1.00*	5.80
Total			$61.80			$79.60
Per acre			12.35			15.92

*Per day.

Leveling.—The larger holes were all filled by turning one or two deep furrows into them; then the balance of the field was plowed, and a large V-shaped road drag made of 3 by 12-in. planks was used for further leveling. This drag was equipped with a heavy ring on each leg at the rear and when alongside a large hole an extra team was hitched to this ring with a cable and the drag pulled sidewise, thus depositing the load of earth in the hole. This operation may be repeated from two or more sides if necessary. A metal plate fastened to the bottom of the drag and extending outward from 2 to 3 in. will increase its efficiency. This method was found to be cheap and very efficient.

The estimated cost of leveling the ground per plot was as follows:

	Hours.	Rate.	Total.
Teamsters	20	$0.25	$ 5.00
Helpers	20	.25	5.00
Teams	20	1.00*	2.00
Feed	..	1.00*	2.00
Total			$14.00
Per acre			2.80

*Per day.

The estimated cost of burning per plot was: One man 80 hours at 25 ct. or $20, making the cost per acre $4. The average amount of powder used for each size of stump is shown in Table I.

General figures on the clearing of the two plots follow:

	Plot No. 1.	Plot No. 2.
Area, acres	5	5
Number of stumps	479	365
Total feet diameter	703.3	674.7
Average diameter, in	14.4	21.2
Powder used, lb	1,678	2,000
Cost powder, ct. per lb	16	17
Cost powder per ft. diameter, ct	39.3	50
Blasting holes, ft	1,220	1,228
Cost blasting per ft. hole, ct	.032	.034
Blasting caps, No 5, No	297	6
Electric fuses, No. 6, No	340	595
Triple tape fuse, ft	422	9

The final cost figures were as follows:

	Total cost.		Per acre.		Cents Per ft. diam.	
	Plot No. 1.	Plot No. 2.	Plot No. 1.	Plot No. 2.	Plot No. 1.	Plot No. 2.
Prelim. work	$ 72.65	$ 73.70	$ 14.53	$ 14.74	10.3	10.4
Making holes	38.90	42.00	7.78	8.40	5.5	6.2
Blasting	34.70	31.35	6.94	6.27	4.8	4.6
Powder	276.50	340.00	55.30	68.00	39.2	50.4
Caps	24.77	38.73	4.95	7.74	3.5	5.7
Fuse	4.22	0.09	0.84	0.02	0.6	0.0
Piling stumps	61.80	73.80	12.36	14.76	8.8	10.8
Burning	20.00	20.00	4.00	4.00	2.8	3.0
Leveling	14.00	14.00	2.80	2.80	2.0	2.1
Total	$547.54	$633.67	$109.50	$126.73	77.5	93.7

Contract for Flood Prevention Work, Dayton, O.—The McWilliams Northern Dredging Co., a subsidiary company of R. H. & G. A. McWilliams, Chicago, Ill., has been awarded a contract by Miami Conservancy District, Dayton, O., for levee work at Dayton. The quantities and unit prices were as follows:

Clearing and grubbing, 2 acres	$150.00
Soil stripping, 8,000 cu. yd	0.40
Levee embankment, 58,000 cu. yd	.50
Cleaning up, lump	500.00

Bids on this work were opened Nov. 15. The bids received at this time for the other contracts were rejected, and the work will be carried out by a day-labor plan, as noted elsewhere in this issue.

TABLE I—AVERAGE AMOUNT OF POWDER USED FOR EACH SIZE OF STUMP.

Plot No. 1.

Diameter, in.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	48	52	56
Sticks powder	1	1.5	2	3	4	4.5	5	6	7.5	8.5	10.5	12.5	13.5	14.5	15.5	16.5	18	19	20	21	24	26	28
Pounds	.6	1	1.2	2	2.5	2.8	3.1	3.7	4.7	5.3	6.6	7.8	8.4	9.1	9.7	10.3	11.2	11.9	12.5	13.2	15	16.2	17.5
Pounds per ft. diam.	1.2	1.5	1.5	2	2.14	2.1	2.06	2.22	2.5	2.65	3.04	2.63	3.36	3.41	3.42	3.44	3.53	3.57	3.57	3.60	3.75	3.74	3.75
Cost per ft. diam., ct.	19	24	24	32	34	34	34	35	40	41	39	42	54	55	55	56	56.5	57	57	57.5	60	60	60
Cost per stump, ct.	9.6	16	20	32	40	45	50	59	75	85	105	128	134	145	155	165	179	190	200	211	240	259	280

Plot No. 2.

Diameter, in.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	48	52	56
Pounds	7	1	1.2	2	2.5	2.6	3.3	4.2	5	5.5	6.2	7.5	8.1	8.8	9.3	10	11.5	12	12.5	13	15	16	17.5
Pounds per ft. diam.	1.4	1.5	1.5	2	2.14	1.9	2.2	2.52	2.7	2.75	2.86	3.21	3.26	3.3	3.28	3.6	3.63	3.6	3.57	3.54	3.73	3.69	3.75
Cost per ft. diam., ct.	24	25	25	34	36	32	37	43	46	47	49	55	55	56	56	61	62	61	60	60	63	63	64
Cost per stump, ct.	12	17	21	34	42	44	56	71	85	93	105	127	138	149	158	170	195	204	212	231	255	272	297

Inverted Transit Gives Lines and Grades in Small Diameter Tunnel

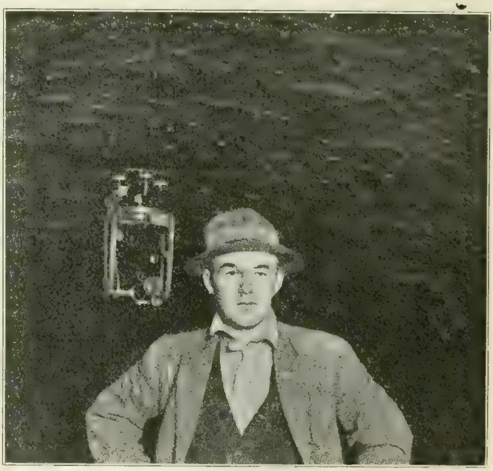
In order to avoid delaying construction operations in small tunnels being driven for the Edison Electric Illuminating Co. of Boston, Mass., the transit used for giving the lines and grades was attached to the roof of the tunnel in an inverted position, allowing the muck cars to pass beneath. The tunnel had an inside diameter of 7 ft., which did not permit of setting up the instrument on its tripod without stopping the passage of cars on the construction track. The method employed was described by Mr. Henry B. Pratt, Assistant Engineer, J. R. Worcester & Co., Boston, in the November Journal of the Boston Society of Civil Engineers, from which the matter in this article is taken.

In order to use the inverted instrument it was necessary first to so arrange the level tube that the bubbles could be seen when the transit was upside down and the vertical arc in its normal position. A Buff transit was used, equipped with a 180° vertical arc, and after having the instrument put into good adjustment it was set up on the tripod, the telescope leveled, and a horizontal line marked about 50 ft. distant, coinciding with the horizontal cross-hair in the instrument, with the vertical arc reading zero. The level tube beneath the telescope was then removed and replaced in an inverted position, the telescope rotated vertically so as to bring the level tube over the telescope with the graduations uppermost, and the level tube so adjusted that when the cross-hair was on the mark the bubble was on center. Now by rotating the telescope back to its normal position and setting the vertical arc on zero, the telescope was brought perpendicular to the vertical axis of the instrument with the bubble on center, although not in a readable position until the instrument was turned upside down. If the transit were equipped with a complete vertical circle, this same object could have been accomplished by rotating the telescope vertically 180° from normal and clamping with the vertical arc, reading that figure which would bring the bubble into a readable position when the transit was turned upside down.

Wooden blocks about 8 in. square were built into the roof of the tunnel as the work progressed, being placed at intervals of about 200 ft. To these blocks were attached metal sockets, such as the transit is screwed to when cased, care being taken to set them approximately on line. When giving line in the tunnel, the transit was screwed to one of these sockets, the vertical arc was set on zero and the instrument leveled by using leveling screws and observing the telescope bubble, which was now above the telescope with the graduations uppermost. It required some practice to level the instrument, as the screws had to be turned in the opposite direction from what they would be if the transit were in an upright position. The instrument was revolved horizontally in leveling, in the same manner in which a Wye level is revolved when being set up. In order to bring the transit on to the exact line, it was slipped laterally on the sliding head and brought on to line by observing two points which had previously been accurately established farther back in the finished tunnel. The telescope could now be rotated vertically and line given ahead in the usual manner. After bringing the instrument on to line, a plug was set in the side of the tunnel at the level of the telescope and an offset read to the center of the instrument in order that the transit could be set on line at any other time without making observations.

When giving grades the telescope was leveled, the height of instrument determined and rod readings taken in the usual manner. After once obtaining the height of the instrument on a "Set-up" on any particular socket it was found that the instrument would be near enough to the same height on successive set-up on this socket to allow of giving grades without a further reading on the bench except in the case of establishing a bench ahead.

In order to prevent wear between plates of the transit due to the liability of particles of dirt working into the joint, the two plates were kept constantly clamped. As a further precaution, some heavy grease was run into the joint so that when the transit was screwed to the roof of the tunnel particles of mortar which would fall on the instrument would be prevented from working into this joint which was then exposed. As the tunnel in which this method was used was straight, there was no occasion to turn any angles or to set the instrument on a point, correct both for line and distance. If it were necessary to run out a curve using an instrument in this manner, it could be accomplished by giving tangent offsets, instead of reading angles, which would be somewhat difficult to do with the instrument upside down. If it were required to set the instrument correct both for line and distance, it could be done by setting two offset plugs, one on line with an offset for distance, the other at right angles to line with an offset to line.


Transit in Inverted Position Attached to Roof of 7-ft. Tunnel.

In using a transit in this manner it is well to tighten the nut at bottom of spindle, so as to take up the play between the plates and also to make the instrument secure, as almost the whole weight of the transit is carried by this nut.

This method of running lines and grades was found to be very satisfactory, as the engineers were enabled to do their work without feeling hurried, as they would have felt if they knew that they were causing the contractor a serious delay.

Flood Prevention Works of Miami Comservancy District to Be Built Bv Day Labor

The directors of the Miami Conservancy District of Dayton, O., have decided to carry out their construction program by day labor. Proposals on this work were opened Nov. 15, but the bids submitted were considered unsatisfactory, and with the exception of those on one contract, were rejected. This contract calling for the construction of a levee at North Dayton was awarded to R. H. & G. A. McWilliams, Chicago, Ill.

Announcement was made last week that the directors of the district had selected Mr. C. H. Locher of Bristol, Va., a member of the contracting firm, Grant Smith & Co. & Locher, to have charge of the construction work in connection with the $25,000,000 flood prevention plans for the Miami Valley.

In making public the announcement Col. E. A. Deeds of the Conservancy District stated:

> The matter of doing the work ourselves was finally set upon as the most feasible, and we concluded that if a highly efficient contractor could be secured to work for this district, and to take upon himself the burden of working out the best equipment, and of organizing the construction methods, his experience would be a great advantage to the district. Thus, the engineers of our district would be free to give their best attention to demanding the perfection in the work they intend to require.

The engineering work will be in charge of Mr. Arthur E. Morgan, who has been Chief Engineer of the District since its organization. Mr. Morgan will be assisted by Mr. Charles H. Paul, Assistant Chief Engineer. Mr. Paul has had over 20 years' experience in construction engineering on big jobs; one of these was the Arrowrock Dam, built by the United States Government under Mr. Paul's direction with a force account organization very similar to the one now being formed for handling the conservancy work.

Under Mr. Morgan and Mr. Paul the important units of the work will be organized as follows:

H. S. R. McCurdy, Division Engineer, will have the Englewood Dam. Mr. McCurdy was formerly Division Engineer on the Ashokan Dam of New York.

A. B. Mayhew, Division Engineer, will be in charge of the Germantown Dam. Mr. Mayhew had charge of the design and engineering on the Arrowrock Dam under Mr. Paul, and other important work of the U. S. Reclamation Service.

The Lockington Dam will be supervised by B. M. Jones, who has had a varied experience in construction work on irrigation dams and power development in the West.

O. N. Floyd, Division Engineer, will have the Taylorsville dam. Mr. Floyd has filled important positions in the conservancy district from the very beginning of the work in the Miami Valley, and has made special studies and investigations of hydraulic fill dams.

The Huffman Dam will be built under the immediate direction of C. C. Chambers, Division Engineer. Mr. Chambers entered the service of the Morgan Engineering Co. in 1907, and before coming to the Miami Conservancy District had charge of the construction of a large project in the south which included the excavation of 14,000,000 cu. yd. of earth.

The channel improvement work at the various cities will be supervised by J. H. Kimball, Construction Engineer, who was connected with the extensive sewer system at Louisville, and with important municipal works in the East.

C. A. Rock, Division Engineer, who has been in charge of important work of similar character in the South, as well as in Haiti, and in South America, where he built the highest railroad in the world, across the Andes Mountains. He will look after the work at Dayton. Mr. Bock has been identified with the preliminary work in the valley for two or three years.

C. H. Eiffert, Division Engineer, will have charge of the Hamilton work. Mr. Eiffert was engaged on railroad, drainage and municipal work prior to his employment by the district.

W. M. Smith, Designing Engineer, was formerly designing Engineer with the Board of Water Supply of New York, and with the Panama Canal Commission.

As noted above, bids on the first contracts for the flood prevention work were opened on Nov. 15. The work advertised called for about 15,000,000 cu. yd. of excavation and 257,000 cu. yd. of concrete. It was divided up into 12 contracts, the approximate quantities in each being as follows:

DAMS.

Contract No. Work.	Excavation, cu. yd.	Embankment, cu. yd.	Concrete, cu. yd.	Paving and riprap, cu. yd.	Iron and steel, tons.
1. Germantown Dam...	200,000	850,000	20,000	1,000	120
2. Englewood Dam.....	375,000	3,500,000	38,000	2,000	180
3. Lockington Dam....	200,000	1,000,000	37,000	1,000	50
4. Taylorsville Dam....	750,000	1,100,000	57,000	5,000	400
5. Huffman Dam......	300,000	1,400,000	45,000	1,500	400

RIVER IMPROVEMENT.

	(1)	(2)	(3)		
41. Miami at Dayton....	....	65,000	.....	....	...
42. Miami at Dayton....	850,000	80,000	25,000	.....	...
43. Miami at Dayton....	465,000	205,000	3,500	.....	...
44. Miami at Dayton....	1,000,000	655,000	2,000	.....	...
45. Mad. at Dayton....	20,000	35,000	1,500	.....	...
46. Wolfe at Dayton....	80,000	25,000	1,400	.....	...
58. Miami at Hamilton..	1,900,000	... ...	27,000	.....	275*

(1) Channel excavation. (2) Levee embankment. (3) Concrete in retaining walls and revetment.

*Reinforcing steel.

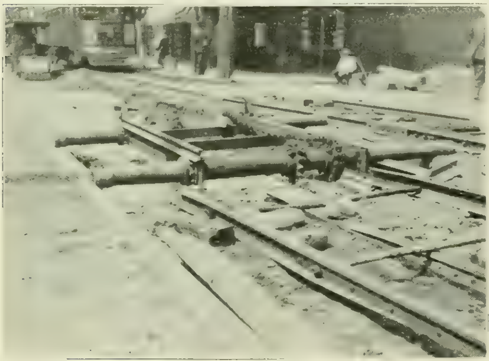
Over $10,000,000 has been subscribed in Holland for the erection of a smelting furnace and a steel and rolling mill at Ymuiden, at the entrance of the North Sea Canal. The products of the works would be intended primarily for shipbuilding. The preliminary plans, however, do not indicate works capable of supplying immediately the full requirements of Holland, but probably about two-thirds of the shipyards' demands will be met, with a remainder available for other industries.

The officials of the Pekin-Hankow R. R. are considering repairing or rebuilding the railway bridge over the Yellow River in China. Repair work would entail expenditures amounting to $11,000,000; and the authorities of the railway company think that in view of the expense, and also in view of the fact that the Yellow River is likely to change its channel at the present site of the bridge, endangering the safety of the foundations, the wisest plan would be to rebuild at some point further upstream, where the river banks seem more stable.

Road Job Calls for 137,000 Cu. Yd. of Excavation.—Bids have just been opened by the State Highway Commission of California on a road job calling for 136,900 cu. yd. of unclassified excavation. The work is in Mendocino County, between Willitts and Arnold and calls for the grading of 8 miles of highway. Erickson & Patterson, San Francisco, the low bidders, offered to do the excavation at 74 ct. per cubic yard.

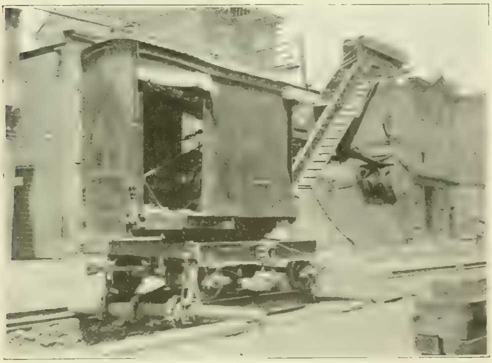
Roller Frame Under Electric Shovel Eliminates Delays in Moving Up

By the use of a roller frame under the electric shovel employed in grading for track reconstruction in city streets the Pittsburgh Railway Co. eliminates all delays in moving up. The frame consists of a 10½-ft. long section of track supported upon rollers, 12 ft. in length. One end of the roller runs upon a light rail set upon the ends of the ties of the track left in service, while the other end runs on the pavement.



Roller Frame for Carrying Electric Shovel.

The shovel is pushed out on the roller frame track and blocked there. The moveahead chain is then disconnected from the axle of the shovel truck and brought down and connected instead to one of the rollers. By this arrangement it has been found that the roller can be moved about with practically no delay, faster even than the shovel would move ahead operating on tractions wheels. Also as the shovel is always maintained at fixed distance above the subgrade it is much easier to take the sub-grade out exactly to the desired finished elevation. The roller frame is so built that it carries the shovel along in such a position as will enable it to take out the subgrade with a slope towards the center of 2 in. in 10 ft. The track work for the Pittsburgh Ry. Co. is carried out under the direction of J. M. Larned, Engineer Maintenance of Way.



Electric Shovel Operating on Roller Frame.

Jetting Apparatus of 1,000 Gal. per Minute Capacity

A jetting apparatus of unusual size was employed by the Holbrook, Cabot & Rollins Corp. in connection with the contract for the construction of the new Thomas River bridge at New London, Conn. The foundation work for this structure necessitated the sinking of some very large open caissons to a depth of 140 ft. through silt and gravel. They were sunk by dredging with grab buckets through open pockets. Bowlders too large to be handled by this bucket were displaced by the jetting apparatus. This consisted of a 1,200 gal. fire underwriters' pump operated by a 250 H. P. boiler delivering water to a 4 in. jet pipe at a rate of about 1,000 gal. per minute under a pressure of 150 lb. per square in. In operating, the jet pipe, handled by a derrick or lighter, is lowered alongside of a bowlder, and a large cavity is at once created into which the bowlder rolls. By repeating the operation for a few minutes the bowlder can be buried to a depth of 15 or 20 ft. below its original position.

Handling Sand, Gravel and Broken Stone by Portable Conveyors

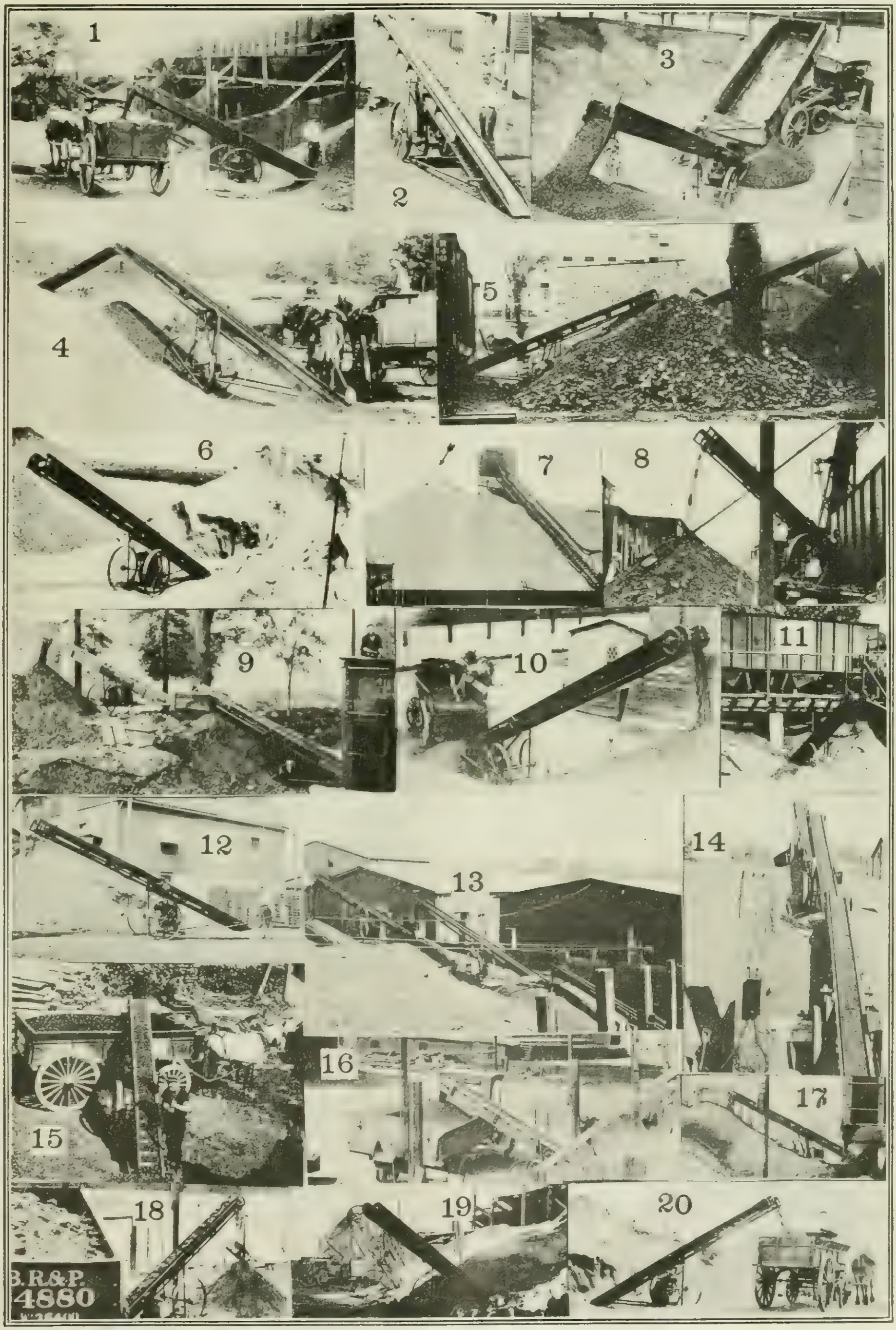
A comparatively new development in the field of labor saving devices is the use of machines for loading, unloading or piling loose materials, such as sand, gravel, broken stone and coal. These machines not only eliminate a greater part of the hand shoveling but they also cut down the hauling costs by reducing the loading time for wagons and trucks.

The loose material handling machines now on the market vary in details, but their essential features consist of a selfcontained power unit—either an electric motor or gasoline engine—and an endless conveying arrangement of the belt or bucket type. The machines are mounted on wheels and can be moved easily from one location to another.

The portable conveyor has many uses. The more common care: loading from storage piles into wagons or trucks; loading from car to wagon or from wagon to car; and unloading cars or wagons to storage. By employing portable conveyors in relays, or a portable conveyor and a fixed conveyor high storage piles can be built up or increased storage space obtained.

The wide range of adaption of the portable conveyors is illustrated on the following page. The machine shown in the half-tone is the type manufactured by the Portable Machinery Co., Inc., of Passaic, N. J. View No. 1 shows the portable conveyor loading from storage into a wagon. In view No. 3 this operation is reversed and the conveyor is loading from truck to storage. In order to obtain a wider range of distribution a chute has been attached to the conveyor. View No. 4 shows the conveyor stacking gravel. In this case the shoveler is required to keep the feeding end covered. The gravel is being passed over a screen. Views 5, 9, 13 and 14 show the conveyors working in relays. By this arrangement high piles can be stacked or the material spread over considerable space. In view No. 20 the conveyor is shown loading directly from a bank.

The first extensive users of portable conveyors were manufacturing companies and coal dealers. Sand and gravel plant operators have found them to be of great service in handling their products, and recently a number of contractors have employed them on their work.



The Portable Conveyor Can Be Adapted to Many Uses. Some of Them Are Shown Above.

Method of Burning Stumps in Place in Land Clearing

As a result of investigations of methods of burning stumps in place in land clearing, Mr. I. D. Charlton, Agricultural Engineer of the Agricultural Experiment Station of the State College of Washington, has reached the conclusion that the burning of branching root stumps in place is not practical and that it is cheaper in the long run to remove the stumps and roots before trying to burn them. The method of burning covered by the investigation are described by Mr. Charlton in a bulletin of the Western Washington Experiment Station to which we are indebted for the matter in this article.

Conditions Best Suited to Burning.—The reason why there are so many stumps and logs remaining after the first burn is due to dampness of the wood, the exposure to an excess of air, and excessive radiation of heat. If the wood is very dry, if the pieces are so arranged that only enough air can come in contact with the fire to carry on combustion, if the pieces cover each other so that heat radiated from one piece warms another, all of the material will burn. If, as occasionally happens, the conditions are just right, the first burn destroys practically all of the trash, logs and considerable of the stump tops.

Stages in Land Clearing.—There are usually three stages to the burning operations. First there is the slashing and first burn, usually followed by seeding and pasture. The second stage includes the picking up, piling and burning of the remaining loose and down material. There remain the larger stumps and an occasional tree or log which must be removed to put the land in suitable shape for tillage.

Burning stumps in place, top burning or burning of the exposed parts of the stumps, is accomplished by controlling one or a combination of the following things: preventing radiation of heat, heating the supply of air before it reaches the fire, or regulating and controlling the supply of air to the fire. The amount of material burned by any method depends upon how well these principles are combined and the adaptability of the method to field conditions.

Char-Pitting.—Char-pitting stumps, or destroying stumps by the methods used in making charcoal, has been very widely advertised. This method consists essentially of excavating just enough between two or more large roots so that kindling and small pieces or chunks of wood when compacted closely in the excavation will when ignited heat and set on fire the base of the stump. The kindling is then covered with dirt, having first so arranged the wood or covered it with leaves or grass as to prevent the dirt from smothering the fire. The dirt cover is extended entirely over the kindling after the coals begin to form. The dirt is kept so packed and of such thickness that the supply of air to the fire is just sufficient to support combustion but not enough to promote rapid burning. Under these conditions charring takes place. The dirt cover reduces radiation. The limited supply of air prevents heat loss that would result from heating an excessive amount of air. The movement of the gases is so slow that the air is heated before it reaches the fire, and a large part of the heat in the burned gases is consumed in heating the burning wood and replacing the heat lost by radiation. The more volatile parts of the wood burn easiest with least amount of air, consequently a large percentage of the charcoal remains if proper burning is secured.

Theoretically, char-pitting is the cheapest way to destroy stumps, but practically the method is a failure, because it is seldom possible to burn all of the roots to a point below the plow line and it is expensive to remove these unburned roots later. A stump is so massive and so exposed to radiation that in order to burn by charring it must contain material like pitch, turpentine, etc., available at a low temperature for burning. This limits the method to fir and a few other less common woods containing sufficient volatile material. When the soil caves due to presence of sand or gravel, or crumbles under heat due to the vegetable matter in it, the fire soon goes out. Clay soil is the only kind which does not cave, retains the heat and does not crumble. Root burning is difficult. The roots contain less pitch, are always wet, and being smaller are more closely surrounded by earth, all of which tends to make the fire go out. If the roots remain they interfere with the cultivation and crop growth and are more expensive to remove than by other methods.

Char-pitting is limited practically to fir stumps when deep rooted on clay soil. Even under these conditions lack of understanding and patience with the method, poor attention to the fires, too much dampness or too little pitch in the stumps mean failure. The method has been so widely advertised that we find few men experienced in land clearing who have not given it a trial. So far in this investigation we have been unable to char-pit even fir stumps on clay soil with general success. Usually one or more big roots remain unburned near the surface. Careful inquiry among men who have tried the char-pit method proves that this is the common experience.

Natural Draft Burners.—Several natural draft burning methods were tried in these investigations, all working on the principle of a stove. These include the following: (1) Holes were bored into the stumps at different angles and positions, such that after a fire was started it continued to burn; (2) The stumps were cut off parallel to and near the ground, the tops pried up and held a short distance from the bottoms by placing small rocks between, and the fire started between the pieces; (3) Metal stoves covering all or part of the stumps, and so arranged with stacks that a draft was created drawing air into the fire through small pipes which heated the air and directed it to where the burning was desired. Some of the methods gave rapid burning, but all failed to destroy all the roots.

Forced Draft Burners.—A blower, engine-operated, was constructed so that it could be used either as a forced draft or vacuum draft machine. In one case the air was forced onto the fire. In the other case the burned gases were drawn over a series of plates, with the intake air passing over the opposite sides of the plates, thus heating the air supplied to the fire.

Both methods gave surprisingly rapid burning, especially when the fire was covered to prevent radiation and the air heated before it reached the fire. When the crown of the stump was burned away and the roots exposed, the number of roots so complicated the burning that the time and labor prohibited the work.

Summary.—The various methods of burning stumps in place which have been advocated usually fail under Western Washington conditions, because in the majority of cases it is impossible by these methods to burn out all of the roots of the stump to a depth that will allow deep plowing. It is easy to burn out the crown of the stump and the exposed parts of the roots.

The real problem is to get rid of the roots that are buried in the soil. Usually after burning all of the crown of the stump and roots that can be burned by char-pitting or one of the other systems of burning, the expense of getting out the remaining roots may be as great or greater than the expense and effort necessary to remove the original stump by powder or machinery.

It is fully recognized that it would be cheaper in both money and effort to burn the stumps where they grew if this were possible. From the time of the earliest pioneers in Western Washington, efforts to accomplish this have been made. The methods briefly described above are only a part of the many methods that have been tried. The fact that after many years' experience in land clearing the majority of people put chief dependence for the removal of stumps in powder and machinery, is good evidence that little success has been obtained in burning stumps in place.

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12 Car Camp Train Used for Housing 150 Men

The car type of camp for housing workmen has been developed to a high state of perfection by the Snoqualmie Falls Lumber Co. of Snoqualmie Falls, Wash. A typical car camp of this company represents an expenditure of about $50,000 and this sum does not include the cost of any of the furnishings in the cars. Each camp contains sleeping accommodations for 150 men and has a dining-room capacity for 180 men.

Each camp consists of 12 cars, seven of which contain the bunks. The cars are 14 ft. wide, 60 ft. long and 9 ft. high from the floor to the Texas. The Texas is 4 ft. high. The cars are tongued and grooved on the inside and painted drab. On the outside they are painted yellow and trimmed with white.

Car Type of Camp of Snoqualmie Lumber Co.

The 12-car train consists of a blacksmith and power car, which contains the blacksmith shop and the electric light and steam heating plant; two cars fitted up for dining-rooms; a kitchen car; a reading-room and warehouse car; one car for bath rooms and drying rooms, and seven bunk cars. The dining cars and kitchen car are 15 ft. wide instead of 14 ft. All the cars are steam heated and have hot and cold water connections and electric light.

The train is made up so that in case of fire it can be pulled out and moved down the road in less than 30 minutes.

The State Highway Commissioner of Ohio is calling for bids for constructing 80 miles of State road, estimated to cost $1,800,000.

Methods of Underground Survey For Wilson Avenue Water Supply Tunnel, Chicago

An interesting description of the survey methods for the Wilson Ave. water supply tunnel of the city of Chicago was given by Mr. H. W. Clausen, Engineer of Water Works Construction, in a paper presented before the Western Society of Civil Engineers. The following account of the methods employed on the underground survey are abstracted from Mr. Clausen's paper:

The method of plumbing the shafts for transfer of the overhead line into the tunnel was alike on all sections of the tunnel.

This method comprised the use of two ordinary transits, reading to 20″, and two plumbing wires from 6 to 10 ft. apart, each carrying a plumb-bob weighing about 10 lb.

The procedure followed in plumbing each shaft was to first carry the line over the shaft by a transit set up on the surface line. The two wires (of No. 1 piano wire) were suspended from the headhouse on this line to the bottom of the shaft.

The transit man on top kept these line wires carefully on line by continual observation. All pumps, the cage, and all other work about the shaft was stopped. the engineer below adjusted the plumb-bobs so as to allow them to hang freely in pails of oil. The oil used was sufficiently thick to prevent the bobs from swinging widely, and served to bring them to rest more quickly than water would do.

The crew on top would signal by tapping on a pipe when the wires were set on line. The crew below, on receiving the signal, would set up their transit on the line of the two wires in the back drift from the one which was to be lined up. The transits were close to the wires, about 50 ft. When the bobs had come to rest the observer would carefully shift the transit until on exact line with the wires, then set a point in the roof of the tunnel close to the shaft and at least one more point nearer the face of the drift. The distance between plumbing wires (6 to 10 ft.) served as the base line on which the underground line was based.

All the shafts were plumbed three or more times while excavating the first 2,000 ft. of tunnel, and about once for each 2,000 ft. beyond that point.

The later plumbing check the stability of the points previously set and also the accuracy of the points carried to the face of the drift from the original points.

The line points are spuds driven into wooden plugs set in drilled holes in the roof. These holes are about 6 in. deep and 2 in. in diameter. A horse-shoe nail with a small hole drilled for the eye is used for a spud.

In some of the drifts platforms were used for transit work. These were built high enough to allow trains and men to pass freely underneath, and in this way the instrument work was carried on without interfering with the work in the tunnel. A trivet was used on platforms instead of a tripod. The transit was set up under the point in the roof from which a plumb-bob was suspended. Grades were carried forward from plugs set in the side of the drift.

For centering the face of the drift for drilling, the line was usually sighted in by the plummet lamps. Sometimes the grade was carried into the face by using plummet lamps, and at other times by using a straight edge about 10 ft. long. Hand-levels were tried but found unsatisfactory.

Three of the shafts being on the line of the tunnel, the surface line was transferred directly to the drift. Two other shafts were located away from the tunnel line to which they were connected by stub drifts, and it was necessary to turn an angle the same as on the surface between the shafts and tunnel line. This angle was checked by repeating the plumbing operations.

In the long drift under the lake (drift 2) from the shore shaft, a novel method of telephone aid was used to speed up the work of checking the line from the shaft to the heading.

Beyond station 14+00, the points were set about 1,000 ft. apart. Three "sight-boxes" were used for foresights, and no backsights were taken. These sight boxes were made to contain two clusters of two 60-watt tungsten lamps, connected to a piece of extension wire plugged into a socket on the lighting wires along the wall. A plumb-bob was suspended from the line point in the roof between the clusters and sighting was done on this bob. The first box was set at a point about 1,400 ft. from the shaft.

After setting the first sight box, the rodman went forward about 1,000 ft. to the next point, and awaited the observer's signal to place the second box.

The observer and the rodman each carried a telephone hand set which were connected to the tunnel telephone wires by scraping the insulation from the wires and making a connection. The observer sighted on the first box, and when he had the vertical hair on the plumb-bob, he would hammer on the power air pipe. The rodman, on hearing the signal, would answer on the telephone, and would then be directed on the telephone to place the second sight box and bob.

When this plumb-bob was carefully set on the line with the first sight, the rodman would take his telephone and the third sight box to the next point, about 1,000 ft. beyond. The rodman's helper would return to the first sight box and remove it for the observer to set the transit at that point. The helper would remain and aid the observer in setting up the instrument, then take the sight box forward to the rodman. The instrument man would foresight on the second box and, as before, sight forward to the rodman and set that point. This operation was repeated until the line was checked into the heading. By this use of the telephone much longer sights were used and also much walking backward and forward to receive instructions was eliminated. Only the helper was compelled to double back on the trip and the entire drift (now 13,000 ft. long) was checked in a single day.

Measurements were made with ¼-in. steel tapes and corrections made for temperature. Permanent points were set on the triangulation surveys and also on the preliminary and location lines. These points were either copper plugs or iron bolts set in the concrete walk or pavements and center punched.

On Sept. 11, 1917, the connection between drifts 1 and 2 was made at a point 14,848.8 ft. east of the Shore shaft.

This connection was practically perfect for line and only .10 ft. out on grade. About 100 ft. before the connection was made, the tunnel was driven gradually to the north of the instrument line, because the assistant engineer was of the opinion that his instrument line was a little south of the true line. This subsequently proved to be the case as the instrument lines were actually 17 in. apart while the connection was perfect.

The connection between drifts 3 and 4 was within 1.2 ft. and drifts 7 and 8 met within 0.2 ft.

The Engineer of Today*

How many engineers are there in the United States? So far as I can determine there are no complete figures on record. There is no general or complete system of registration for engineers. The nearest approach to it are the records of the engineering societies. The four largest engineering societies have a combined membership of about 30,000; we can assume that the duplicates in their lists are more than offset by the membership in smaller organizations. The number not enrolled in these societies must be a matter of speculation; certainly the number not enrolled is equal to the enrolled membership, and from some observations that I have made I can conceive that it might easily be twice as great. Thus with the registered membership of 30,000 as a basis, the total number of engineers in the United States may be estimated at anything between 60,000 and 100,000. In a circular of the United Engineering Society the number is placed at 73,000. Taking the larger number 100,000 as the basis of discussion, there is one engineer for each 1,000 of our population, or one-tenth of 1 per cent. This seems a small proportion, and it is indeed so, but it is ever increasing, and I think no one would attempt to fix any definite limit as the maximum number that would be useful among our people. When we consider that the profession is little more than a century old, that 100 years ago there probably were not a 100 engineers in this country, these figures are significant.

While the proportion to the total population is small, the distribution is fairly even throughout the United States. Engineers are to be found in every community, and are known in the most remote districts. This thorough distribution places them in a position to leaven the entire mass of our population so that their influence can be made to be felt everywhere.

These figures are useful, not for their absolute value because that is so uncertain, but for giving the impression that the gross number is large and the proportion is small. The wide and tolerably uniform distribution of engineers is the interesting point.

The field of engineering practice is so broad and its outer limits merge so much into other things, that it is almost impossible to give it definite boundaries. It comes in contact with and interlocks with manufacturing, trading, promotion, scientific research, law, medicine, agriculture and in fact almost every form of human endeavor. The work is so diversified that it is difficult to realize that it all belongs to our profession.

Within itself the vocation is arbitrarily divided into four fields, viz.: Civil, Mechanical, Electrical and Mining, to which might be added Military and Marine Engineering. The division between these fields is not a straight fence, but is more like a barbed wire entanglement, in that does not follow a well defined line; quite unlike it in that there is no barrier between the divisions and they lap over and merge in a way that makes it impossible to mark a definite separation. Each of these major divisions in turn is subdivided into an indefinite number of minor divisions, each having its own little sphere more or less definitely defined.

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*From an address presented before the Iowa Engineering Society by Mr. Henry J. Burt, president of the Western Society of Engineers.

With this great diversity of occupations, with its members scattered broadcast, is it any wonder that there is lack of unity and common purpose? The wonder is that there is anything in common.

The relation of the engineer to his work merits consideration. The great majority of engineers are employed rather than retained, meaning by employed that his whole service is rendered to a certain employer for a salary, and by retained this his service is rendered in a specific matter and compensated by a fee. The former is continuous employment for a greater or less period of time for a single employer. The latter is special employment for a particular purpose and the practitioner may be so engaged to any number of employers at the same time. Such a practitioner is known as a Consulting Engineer.

The consulting engineer is generally conceded to be at the head of the profession, and his practice to be the most desirable form of service. Some contend that these are the only ones who are entitled to be called professional engineers. But we are concerned with facts and conditions, so we will not argue about definitions. It seems that the consulting engineer has greater liberty of action and is less subject to the will of his employer than the salaried man, and so he can do his work without bias. To the extent that salaried men are restrained somewhat in their solution of the problems put before them, their conclusion warped by the wishes of their employers, and their development forced along certain lines and retarded along others, to this extent salaried employment is undesirable. But the consulting engineer has like troubles and I am not sure that he is more fortunately situated or entitled to higher standing than his salaried brother.

From the very nature of the work to be done all cannot be consulting engineers, not even a considerable percentage. The great number must be salaried men. The consulting engineer if he does much work must have assistants, perhaps a hundred of them. The assistant may be a better engineer than the chief, but there must exist the relation of master and man. Engineers seldom work alone but in groups, for most engineering works are of such magnitude as to require several men or of such character as to require men of varied qualifications. Such groups are usually under the command of an engineer. So it is that most engineers are employed by, or work under, the direction of other engineers, a most desirable relation and one that must have had much to do with the rapid development of the profession. The young man starts out with a college education, is employed under a man of experience and gets the equivalent of apprenticeship, and, advancing, gets the benefit of higher grades of direction until he himself becomes the head of an organization. Could there be a better system of development? As in all other lines of endeavor, advancement will be influenced both by ability and by opportunity. In some cases promotion will be unmerited, in others merit will be unrewarded.

As in other callings this one has its problem of compensation. No need to worry about those who are well advanced in the profession. They can command adequate reward for their services. But the great number of beginners and men in the lower grades need consideration. Every live man has an ambition to improve his condition, and having this desire he is easily and frequently persuaded that he has earned an advance in salary. There undoubtedly is considerable unrest on this account. I will not enter into a lengthy discussion of the proper compensation. Suffice it to say that beginners, college graduates, receive about the same pay as common laborers, and men of 10 years' experience about the same as unionized mechanics. Considering the time and money cost of an education and the importance we assume for this profession, such compensation does not seem adequate.

Closely allied to compensation is continuity of service. In both large and small organizations there is a tendency to hire and fire according to the pressure of work. Little effort is made to control the work so as to maintain a uniform force. This cannot be closely controlled due to the fluctuating business conditions of the country, engineering employment being peculiarly susceptible to these fluctuations. But there is some possibility of improvement.

Inasmuch as most engineers are employed by or under the direction of other engineers, the question of pay is a problem within the profession more than it is an issue between the profession and the public. So on you employing engineers rests the responsibility of its solution.

The engineer of today is a man of character. Study if you will the enginers whom you know intimately and I believe you will find almost without exception that their characters will stand the closest scrutiny, and analysis. This is so not because they are made of superior clay for they come from all sources and conditions. I believe it is because their education and the nature of their everyday occupation make for the building of strong and rugged elements of character.

Higher education in itself is a great builder of character. This can be conceded without discussion. But even more important is the effect of his employment. He deals with facts or with data which are as nearly true as he can ascertain. His first act in entering upon any enterprise is to establish the truth about the attendant conditions and on this foundation he fabricates his structure. Woe be to the engineer who purposely or carelessly distorts the data on which he bases his work. He is doomed to failure. He must be honest with himself, and that makes him honest with his fellow men.

He deals with affairs of greater or less magnitude and thus gets breadth of vision or more accurately he is obliged to see his problem from all viewpoints, study it from all angles, picture the result from front and rear, from inside and outside, from above and below, see the structure in the brilliance of its newness and dullness of its age. Where most people are satisfied to think twice he must think twenty times, else he will miss some element of the problem and reach the wrong conclusion. Thus the necessities of the case make him thorough.

As a usual thing, the engineer is not an advocate. He is more often an arbiter. His habits of work tend to develop a judicial mind, for he must decide questions of fact, must weigh relative values, and must conclude from the preponderance of evidence. This enables him to treat all people fairly whether they be clients, employers, employes or the general public. Although not usually an advocate there are times when he should be one. When his studies have led to conclusions that are unassailable he is justified in being an advocate, and in matters of public welfare should be a most positive and persistent advocate. But in matters of a controversial nature and matters in the interest of private business, the ground is dangerous. It is almost out of the question for an engineer in such cases to keep free of bias and partisanship. To speak plainly he is tempted to be dishonest.

The work of the engineer is largely of a public nature. Military work is directly so, as also is the work done for the general government, the State and the municipality. Less directly so are public utilities, railroads and telegraph. Marine work, ship building and anything concerned in foreign commerce are not much removed from public work or public utilities under present conditions. The construction and operation of manufacturing plants intimately concern domestic commerce and hence the public welfare. Mining and the related industries are in the same category as manufacturers. Surveying of land affects not only the property surveyed but also adjoining property and is, therefore, a quasi public function. The public has an interest in everything we do.

Engineering is a productive industry which may fairly be rated as being exceeded in importance only by agriculture and perhaps manufacturing. To me it is one of the greatest satisfactions I get from my work to know that it contributes something to the wealth of the community and adds to the comfort and convenience of people.

Our work is not finished and never will be so long as our present form of civilization lasts. There is still more of the same kind of work to be done, and new problems to be solved. Much of our designing is still on an empirical basis. The rational solution is needed. Much of our construction is still experimental and must be studied and improved by experience. Some day our coal will be gone and our oil exhausted, then we must harness the wind and the heat of the sun. When the copper supply runs low it may be necessary to train the electricity to jump from station to station. We now purify our water supplies —soon we may need to purify the air in congested centers. The impatient people are demanding quicker transportation between residence and business. We cannot forsee what the future has in store. It may give new things quite as remarkable as those of the past.

Let us take a look at the engineer in his home town. We see a law abiding citizen, modest, a man of high character, too reticent of his doings, lax in public affairs. He has the standing of the average citizen. His neighbors know he is an engineer, but have little conception of what he really does. There may be another of his kind a few blocks away.

His standing in his community can be what he chooses to make it. He has the foundation and the qualities of leadership and can be a leader if he chooses to be. He needs publicity. His neighbors should know what he does and, more important, what he is capable of doing. If his talents are not demanded in public affairs, he should volunteer them.

The public, through its schools and colleges, has made the engineer a superior man. By this means the public acknowledges his importance to the body politic and by thus educating, places him under obligations to his state and to his country. He is a public character who has been educated at public expense and his work is of such a nature that the results of it have an influence on public welfare. With all this goes great responsibility, particularly in view of the fact that his own developments are responsible for so many of the public problems. It may be argued that his responsibility ceases with the performing of the particular things that he has been educated and trained to do—that he has no public responsibility outside of the practice of his vocation. Under certain circumstances an engineer might fulfill all his responsibilities by the practice of his vocation, but in most cases this is not so, for his practice is designed primarily to contribute to his own benefit. Comparatively a small part of the work which he does is done for the general good without direct compensation therefor. However, there are many exceptions to this, and a great many people are serving the public freely in a professional way in addition to the regular pursuit of the vocation.

This return service to the public or to the state, need not be in the line of his profession or vocation—it may take any form. It may be in the form of charity—it may be in the form of social service—it may be in every-day politics—it may be in volunteer work on public committees or commissions. It may be even the apparently small service of co-operating with his neighbors in any movement for betterment of local conditions. A great many men are giving such public service—perhaps only in a small degree, but in some degree. It seems indisputable that every engineer owes service of this kind in compensation for his education and as a direct responsibility in connection with his work, for I believe responsibility is measured by one's ability to do and that it cannot be equally divided among all people. Those of meager attainments and small capacity cannot be called upon to assume the same responsibilities that must be shouldered by men of great attainments and great ability.

Breaking Up Hard Pan in Creek Bottom With Dynamite

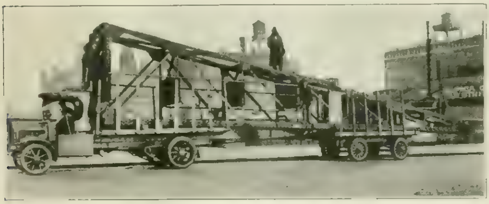
In securing gravel from the bed of a creek near Hazelwood, Ind., by means of a heavy drag chain with buckets attached, a layer of hardpan was struck at a depth of about 6 ft. The buckets frequently jammed in this hardpan and stopped operations until they could be loosened. The hardpan was about 18 in. thick and was underlaid by good gravel, but as the buckets would not penetrate it, only the gravel above was being used. Finally the chain and bucket became jammed in the hardpan about 6 ft. under water. To loosen the arrangement Red Cross dynamite was used to make up several one-cartridge primers with a cap, and about a foot of fuse for each cartridge. These were lighted and dropped into the water at 10-ft. intervals along the chain, while at the two ends, where the hardpan seemed to be the strongest, two cartridges tied together were used. The machinery was then started up, and the chain was found to be free, the buckets coming up full. The blasting had not only loosened the chain and buckets, but had broken up the hardpan and loosened the gravel, so that every bucket worked to capacity. During a timed 4-hour run immediately after the blasting, 40 cu. yd. more of gravel were excavated than had ever been done in a similar period before.

The Western Pacific R. R. has awarded a contract for constructing 23½ miles of line from Niles to San Jose, Cal. The Utah Construction Co., Ogden, Utah, secured the work at about $800,000. Another fair sized railroad job let in the last few days calls for track elevation work in Dallas, Tex., for the Missouri, Kansas & Texas R. R. The contract amounts to approximately $400,000.

Corsicana, Tex., at an election Dec. 11 adopted the Commission form of city government. Rahway, N. J., also adopted this form of municipal government at an election last week.

Transporting Pile Driving Outfit by Motor Trucks

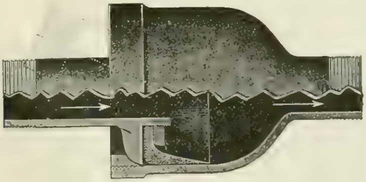
A complete pile-driving outfit was moved recently a distance of 25 miles in 18 hours by means of motor trucks and trailers. The Emergency Fleet Corporation had commandeered the plant of a large shipbuilding company on the Atlantic Coast. Extensions to the plant for the purpose of increasing production included new shipways supported on large concrete piles. The Raymond Concrete Pile Co. was awarded the contract for driving the piles on condition that it would begin work within 2 days. The contractor's nearest pile-driving equipment was in the League Island Navy Yard, 25 miles distant from the new work. Railroad facilities were not available. Accordingly the entire outfit, consisting of the tower, turntable and bed sills, boilers, engines and additional equipment were hauled by motor trucks at a considerable saving in time and money. The hauling was done with White trucks owned by Stedman Bent of Philadelphia.



Method of Carrying Pile Driving Tower on Truck and Trailer.

Flexible and Expansion Joint For Pipe Lines

A flexible joint that obviates many of the difficulties encountered in the installation and maintenance of pipe lines has been placed on the market by the Iron-Clad Joint Co., Godchaux Bldg., New Orleans, La. The joint has five actions: A ball joint action; expansion joint action; flexible action to take up vibrations; suction and discharge. It is claimed to be especially adapted for all hydraulic or air lines that have to be moved frequently. It is being used for connections to centrifugal pumps on temporary construction; for steam lines on dipper dredge boats, steam shovels and other similar machinery where there is considerable vibration and strain and for connections on pontoon dredge pipe lines. On the last mentioned installation it is stated that the joint will take every action caused by the waves.



Sectional View of Berry Flexible Joint.

Proposed Specifications for Air Line Hose for Pneumatic Tools

At the last annual meeting of the American Society for Testing Material a committee report was submitted containing tentative specifications for air line hose for pneumatic tools. The specifications cover wrapped air line hose suitable for air tools working at not more than 125 lb. pressure and for vacuum outfits. Extracts from the specifications follow:

The hose shall consist of: (a) An inner rubber tube; (b) cotton reinforcement; (c) an outer rubber cover; (d) when specified, an extra covering of cotton wire.

The rubber tube shall be smooth, uniform in quality and thickness, and free from injurious defects.

The reinforcement shall consist of cotton canvas plies made from duck evenly and firmly woven from good cotton, as free from unsightly defects, dirt, lumps, knots and irregularities of twist as is consistent with the best manufacturing practice. It shall be well frictioned on both sides with a rubber compound suitable for the required service. The plies shall be laid on the bias and be sufficiently strong to enable the hose to successfully withstand the hydrostatic pressure test; yet at the same time be soft and pliable.

The rubber cover shall be uniform in quality and thickness and be free from injurious defects.

When specified, the hose shall be given an extra covering of one of the following, as specified: (a) An armor of half-round wire 7/32 by 5/64 in. spaced ¼ in. part; (b) canvas; (c) cotton braid.

Unless otherwise specified, the hose shall be furnished in 50-ft. lengths. The ends of each length shall be uncapped and without fittings.

The minimum tube and cover thickness shall be as follows:

Size in	Minimum Tube Thickness. in.	Minimum Cover Thickness. in.
⅜	1/16	3/64
½	1/16	3/64
⅝	1/16	3/64
¾	3/32	1/16
1	3/32	1/16
1¼	3/32	1/16

News Letter

St. Louis Items.

Jos. H. Vorst of St. Genevieve, Mo., was awarded the contract for building new levee in St. Genevieve County, Mo. There is approximately 116,000 yards of earth to be moved in this job.

W. A. Gierke secured another piece of work from the Burlington R. R. near Boulder, Ill.

L. J. Smith and P. J. Hannan returned from Dawson Springs, Ky. Their work on the I. C. R. R. at that point is getting along nicely.

"Big" Riley of Clapp, Norstrom & Riley, was with us several days. Riley did a good business and some entertaining during his stay.

Keating Bros. report that they have enough work for their outfit on the Chicago & Illinois Midland R. R. to keep them busy until the early part of next summer.

J. L. Beecher of the Beecher Improvement Co., St. Paul, Minn., disposed of 20 mules at the National Stock Yards here. Beecher says he can't work mules to advantages up in his country.

Mulvill Bros. of Alton, Ill., were awarded contract for building the new yards on the Chicago & Alton R. R. for the coal mines recently bought by the Standard Oil Co. at Carlinville. They have a couple of jobs in Missouri on the C. & A. R. R. that are suitable for small team outfits to sublet.

J. J. Wuellner & Son, Oak and Front Sts., Alton, Ill., want a few teams on city work there.

John Marsch secured contract for building the reservoir near Sawyerville, Ill.

McMillan Contracting Co. have temporarily suspended work on their Northwestern job near Benld, Ill., on account of cold weather. They will resume as soon as weather moderates.

Scott Mitchell of the L. J. Smith Construction Co., who broke his collar bone some time ago, is up and around again. Scott is down at Dawson Springs, Ky., at the present time looking after their I. C. work.

Dave Griffith is batching on his 10,000 acre farm near Wallace. Kan. Dave is chief batcher and Lefty Snyder, his old stable boss, is assistant. His friend McMurray informed the writer in Kansas City the other day that while Dave was not making any money in the contracting business just now (on account of having no contracts) he had plenty to eat and drink in his bachelor quarters for the rest of the winter. What he had to drink McMurray did not state, but we suppose Dave's friends will know.

J. W. McMurray Contracting Co., Kansas City, Mo., is doing the bridge work on the new 85-mile extension of the Santa Fe R. R. out of Shattuc, Okla.; also on the 35 miles of the new Santa Fe line out of Hollyrood, Kan. In addition to this they have a half a dozen concrete jobs on the Missouri, Kansas & Texas R. R. in Kansas and Oklahoma.

R. T. Amis is building a reservoir for the Missouri, Kansas & Texas R. R. at McAllister, Okla. Also has a team job from the L. J. Smith Construction Co. on this road at Parsons, Kan.

A. A. Luck is building a double track for the Santa Fe R. R. at Turner, Kan.; also has a team outfit at work at Peoria, Ill., on the Burlington R. R.

Wood, Bancroft & Doty have taken quite a slice of Maney Bros.' work on the Santa Fe R. R. at Pawhuska, Okla. L. Viall is in charge of their shovel at this place.

T. L. Campbell has finished 7 miles of the Santa Fe work that he had from John Scott & Sons at Hollyrood, Kan., and moved this outfit on to a drainage job at Belleville, Kan. Campbell also has a small coal stripping job at Worland, Mo.

Clark & Jackson have finished their station work on the U. P. at Ft. Riley, Kan., and are in the market for more of this kind of work. Write them at Mound City, Kan., or care of Koenig's Labor Agency, Kansas City, Mo.

Al. Gillen fell and broke his arm the other day.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

Thos. L. Rosser, Jr., is making things hum on his I. C. R. R. work near Dawson Springs, Ky.

A. B. KOENIG.

Personals

W. H. Rupert has been appointed Superintendent of Streets at Lorain, O.

Edwards Pendleton has been appointed Superintendent of Highways of Chenango County, New York.

W. M. Carter has been appointed City Surveyor of Woodbury, N. J., succeeding his son, who resigned to enter the 23rd Engineers Regiment.

F. G. Whaley, formerly City Engineer of Chehalis, Wash., has been appointed examiner for the state bureau of inspection and supervision of public offices.

A. E. Hutchinson has resigned as City Engineer of Albuquerque, N. Mex., and has accepted a position as Superintendent of Construction for the Federal Government.

William A. Pillans, assistant to the Engineer of Maintenance of Way of the Lorain, Ashland & Southern R. R., has been appointed director of Public Service of Lorain, O.

Paul Latchem has been reappointed City Engineer of Huntington, Ind. John P. Bailey has been appointed Street Commissioner and Henry Grupe Superintendent of Water Works.

F. B. Moore has resigned as Superintendent of the municipal electric light plant and water works of Eaton Rapids, Mich., and has accepted a position with the General Electric Co.

Nathaniel S. Chase and Myron P. Howland have entered into a partnership and will carry on a practice as industrial and mill engineers and architects, with offices at New Bedford, Mass.

George L. Smith, erecting engineer for the Fort Wayne Electric Works, has been appointed superintendent of the water works and the electric light and power departments of Fort Wayne, Ind. He will assume his new duties on Jan. 7.

Fred C. Whaley, for the past four years city engineer and water works superintendent of Chehalis, Wash., has resigned to accept a position as engineer in connection with the public utility work of the state department of examination under the state auditor.

Charles A. Wright and E. C. Morgan, architect, formerly of Kansas City, Mo., have formed a partnership for the purpose of specializing in Indian Pueblo architecture, landscape gardening and interior designing. Offices have been opened in the Wright building, Albuquerque, N. Mex.

Maury Nicholson, assistant city engineer of Birmingham, Ala., will sever his connection with the municipality Jan. 1 to become engineer in charge of municipal construction for the Chickasaw Shipbuilding Co., a subsidiary of the United States Steel Corporation, which is building a large shipbuilding plant at Mobile.

Robert A. Meeker has resigned his position as state highway engineer of New Jersey and will be succeeded by William G. Thompson, who has been assistant state highway engineer since last April. Edward C. Reed, heretofore division engineer in the department, succeeds Mr. Thompson as assistant state highway engineer.

R. C. Stevens has been elected president of the Engineers' Society of Northwestern Pennsylvania. The other officers are: Armin Schotte, first vice president; F. S. Newhard, second vice president; M. C. Emanuel, secretary; W. H. Reynolds, treasurer; C. H. Schum, director for two-year term.

Coleman B. Mark, for the past 8 years a member of the engineering department of the State Health Department of Pennsylvania, has received a commission as first lieutenant in the United States National Army, and has been assigned to the Sanitary Corps, 76th Division Headquarters, Camp Devens, Ayer, Mass.

Henry W. Hayman, of London, Ont., has been elected president of the Mason Contractors' Association of the United States and Canada. Mr. Hayman, who has held the office of first vice-president, succeeds W. S. Felton of Buffalo, N. Y. Walter W. Wise, an Indianapolis contractor, was elected first vice-president; George Moore, of Detroit, Mich., was elected second vice-president, and L. A. Griffin, of Cleveland, was re-elected secretary-treasurer.

Fred C. Carstarphen has been elected president of the Engineers' Club of Trenton, N. J. Alfred P. S. Bellis was chosen second vice president; Joseph E. English, secretary, and John E. Elliott, treasurer. Charles R. Fairchild, second vice president last year, automatically advanced to the first vice presidency. The new Board of Governors is made up of State Comptroller Newton A. K. Bugbee, Frederick W. Bechtel, Alfred C. Gregory, J. Osborne Hunt, Edward E. Reed, John W. Thompson and Frank F. Frederick.

John R. E. Turpin has been appointed roads engineer of Queen Anne County, Maryland, to succeed Frederick E. Schnepfe, who recently resigned to accept a position with the Portland Cement Association. Mr. Turpin was formerly employed as a civil engineer for a number of western railroads, but the last few years he has devoted to farming and dairying on his farm. Engineer Schnepfe was the first appointee under the law creating the office of roads engineer in Queen Anne County and was serving a second six-year term.

Leonard S. Cairns, assistant general manager of the Manila Electric Railroad & Light Co., Manila, P. I., has been appointed general manager of the Eastern Pennsylvania Railways Co., Pottsville, Pa., by the J. G. White Management Corporation, New York City, the operating managers of both companies. Mr. Cairns has arrived in the United States and has assumed the duties of his new position. He succeeds L. H. Palmer, who lately became assistant to the president of the United Railways & Electric Co., Baltimore, Md., as recently announced in these columns. Mr. Cairns, upon leaving high school, entered the employ of the Twin City Rapid Transit Co., Minneapolis, Minn., and, after several promotions, was made general superintendent of that company. In 1912 he was employed by the J. G. White Management Corporation to fill the position of assistant general manager of the Manilla Electric Railroad & Light Co.

Charles T. Main, consulting engineer, of Boston, has been elected president of the American Society of Mechanical Engineers. Mr. Main was born in Marblehead, Mass., in 1856 and was educated at the Massachusetts Institute of Technology, from which he was graduated in 1876. Three years later, after continuous service in the institute as assistant in the department of mechanical engineering, he became a draftsman at the Manchester Mills, Manchester, N. H., leaving this concern in 1881 to enter the employment of the Lower Pacific Mills, Lawrence, Mass., where for eleven years he acted in the respective capacities of engineer, assistant superintendent and superintendent. Since 1892 he has practiced as a consulting engineer, with offices in Boston, until 1907 being associated with F. W. Dean in the firm of Dean & Main. Mr. Main has designed and supervised the construction of numerous industrial, steam power and water power plants, among his largest undertaking being the Wood Worsted and Ayer Mills in Lawrence, Mass., and four hydro-electric developments for the Montana Power Co., aggregating about 280,000 horsepower. Mr. Main became a member of the American Society of Mechanical Engineers in 1885 and has served on its board of managers for the past three years. He is also a member of the American Society of Civil Engineers and a number of other engineering and technical societies.

Obituaries

H. D. Langworthy, Jr., for the past 6 years superintendent of the Water Department of Macon, Ga., died Dec. 11 at his home in that city.

Robert J. Graham, 72 years old, a pioneer building contractor and banker of Pittsburgh, Pa., died suddenly Dec. 11 on a Brighton road car, near his home.

Thomas A. Cashin, superintendent of the San Francisco Municipal Street Railways, died last week. Prior to his employment by the city he was superintendent of the Fresno Traction Co., and before that had been assistant engineer of way construction for the United Railroads.

Joseph Morgan, Jr., for years chief draftsman of the Phoenix Iron Co., Phoenixville, and chief engineer of the Edgmoor Iron Co., died at Johnstown, Pa., Dec. 9. As consulting engineer of the Cambrai Steel Co. and as a member of mechanical and mining societies and the United States Naval Institute, he was widely known.

Clarence W. Ide, a pioneer contractor of the State of Washington, who served during his life in the position of state supervisor of public money, state representative, state senator, United States marshal for Washington, collector of customs for the Puget Sound district and superintendent of the King county court house, died at Seattle Oct. 9, aged 57 years.

James H. McShane, a pioneer contractor of Omaha, Neb., died Dec. 9 at his home in Omaha. He was born in Springfield, O., in 1841. He was engaged in the construction of the Pacific telegraph line from Omaha to Salt Lake. In 1864 he struck out from the Overland trail and conducted a freight caravan to Virginia City, then the first and liveliest of the mining camps of Montana. Here he made his headquarters for three years and built under contract the telegraph line from Helena through Virginia City to Salt Lake City. From this work he turned to railroad construction and became one of the contractors of the Union Pacific.

Industrial Notes

The Sullivan Machinery Co. has moved its Salt Lake City, Utah, offices from the Kearns Bldg., to Room 1606 Walker Bank Bldg. Burt B. Brewster is manager of the office.

Blaw-Knox Co., Pittsburgh, Pa., has closed its Philadelphia office for the present and Mr. Pulis, who had been in charge, has been transferred to the San Francisco office to take the place of Mr. Burrows, who is going tinto the service of the government.

B. F. Affleck, Chicago, was re-elected president of the Portland Cement Association at its annual meeting at the Hotel Biltmore, New York, Dec. 12. Mr. Affleck is president of the Universal Portland Cement Co. F. W. Kelley, president Helderberg Cement Co., Albany, N. Y., was elected first vice president, and Richard Hardy, president Dixie Portland Cement Co., Chattanooga, second vice president. G. S. Brown, president Alpha Portland Cement Co., Easton, Pa., was elected treasurer. The Portland Cement Association has turned its activities largely to the promotion of permanent roads in line with the desire of the Council of National Defense that through routes be quickly developed to supplement the railways, especially for short-haul traffic.

J. C. Bannister has been made a vice president of the Walworth Mfg. Co. of Boston, Mass., manufacturers of iron pipe fittings, valves, Stillson wrenches, etc. Mr. Bannister has been connected with the manufacture of this type of product for 26 years, starting as foreman of the tapping department of Haxtun Steam Heater Co. at Kewanee in 1891. He advanced successively to superintendent of pipe finishing mill, and chief engineer. For three years superintendent of Kewanee Boiler Co. When National Tube Co. took over the operation of Kewanee plant Mr. Bannister was made manager of Kewanee works. Walworth Mfg. Co. purchased the Kewanee works in August, 1917, and Mr. Bannister has now been made a vice president of that company, although his headquarters will still be at Kewanee, Ill., and no change in the management there is at present contemplated.

Building and Structural
Monthly Issue

ENGINEERING *AND* CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and one quarterly issue of E. & C. entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special issues may be subscribed for as a monthly at $1.00 a year, or any two monthly issues at $1.50 a year. The Price and Market Quarterly, published on the 5th Wednesday of 4 months, may be taken separately at 25 cents a year.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power

Excavation and Govt. Works—3rd Wednesday
- (a) Excavation and Dredging
- (b) Rivers and Canals
- (c) Harbors and Docks
- (d) Railway Construction

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Ship Construction
- (d) Miscellaneous Structures

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Should Only the Best Engineering Students Be Exempted from Draft?

Engineering and Contracting was the first to urge exemption of engineering students from draft. Other engineering periodicals were not slow in taking the same position, and finally the Society for the Promotion of Engineering Education joined in the movement for engineering student exemption. On Dec. 8 the Secretary of War issued an order under which the Chief of Engineers was empowered to prescribe the conditions under which a portion of the engineering student body may be exempted. The following is the exemption certificate to be signed by the president of the college:

> I hereby certify that .... is a regular student of the .... class in good standing, as a candidate for an engineering degree at .... and that in the judgment of the faculty of this school, based upon his academic record, supplemented by his relations with fellow students and by observation of his instructors, he may fairly be regarded as deserving a place in the first third qualitatively of the young men graduating from this institution during the past ten years.

It will be seen that to secure exemption a student must have a scholastic standing that would put him among the upper third of the average class for the 10 years preceding.

While it is gratifying to record this recognition of the importance of exempting some engineering students from war service, we feel that it was a serious mistake to have limited the exemption to "the upper third."

Every engineering college has its own standards of scholarships, and nearly all of them are so severe in their requirements that both loafers and incompetents are speedily weeded out. Why, then, should two-thirds of the men who are regarded by their instructors as competent be now weeded out and forced to enter the army? Is it because the country will need only one-third the number of engineers graduated in normal times? Merely to put this question is almost sufficient to show the lack of wisdom in providing for an exemption of "the upper third" only.

We trust that the American Society for the Promotion of Engineering Education, aided by the great national engineering societies, will continue the fight to secure exemption for all engineering students. As we understand it, all medical students are exempt; and it needs only an educational campaign to make it perfectly clear that the same reasoning that leads to the exemption of all student doctors should lead to the exemption of all student engineers.

An Opportunity for Structural Engineers and Contractors: Building Industrial Villages

When manufacturers publish handsome catalogs showing the homes that they provide for their workmen and use these catalogs to attract the better classes of workmen to their factories, it is safe to announce that we have entered on a new industrial era—the era of "the wage-earner be pleased."

The Connecticut Mills of Danielson, Conn., has just issued such a catalog, entitled "The Village Beautiful." On its cover we read: "Take Your Choice: Home or Hovel. It costs the same. Better wages, better homes at Danielson, Conn." The booklet shows photographs of the houses, no two of which are alike, and tells how each workman can buy a home on the installment plan.

The Danielson Construction Co. built "The Village Beautiful." In our last Building and Structural Monthly issue we described the building of several other industrial villages for workmen, among them being one for the Goodyear Cotton Mills, built by the Aberthaw Construction Co. of Boston, and one for the Youngstown Sheet & Tube Co., built by the Unit Construction Co. of St. Louis.

It is evident that structural engineers and contractors will find an increasing amount of work of this sort; for the tendency, more and more, is to abandon the old hovel manufacturing and mining towns and to build entirely new villages for workmen, where not only nice homes but ample playgrounds for young and old can be provided.

Should Not the Government Insist on the More General Use of Gas-Filled Lamps to Save Fuel?

It was many years after the introduction of the tungsten electric lamp before the old carbon lamp was generally displaced. History is repeating itself, for the efficient gas-filled or nitrogen lamp is replacing the tungsten lamp almost as slowly as the latter replaced the carbon lamp. Naturally the electric light companies have not advertised the saving in electric current that their customers can secure through the use of more efficient incandescent lamps. But, now that the scarcity of coal has forced curtailment of the use of electricity for lighting, should not the federal government itself give wide publicity to the economy of gas-filled lamps?

Indeed, might not the government be justified in forcing the electric power companies to provide their customers with gas-filled lamps in place of tungsten and carbon lamps, except for the smaller sizes of lamps? Here is a case where economy for the public so reduces profit for the purveyors of electricity that governmental action of some sort seems imperative.

Engineers Should Require Their Subordinates to Read Engineering Periodicals Systematically

College education should consist, for the most part, in the forming of habits that will insure subsequent mental and moral development. Among these habits should be the habit of systematic reading of technical periodicals. Unfortunately, most engineers graduate without having formed such a habit, and many of them never acquire it in after life. Consequently we see uneconomic designs and uneconomic construction methods on every hand, for he who fails to study the current progress inevitably does inferior work. It would be well if every engineer in charge of other engineers were to insist on their studying the engineering periodicals systematically during a part of their daily "working hours." It is not sufficient to advise them to read. They should be made to do so as part of their weekly duties.

Ex-President Taft Opposes the Conscription of Engineering Students

Addressing the American Society of Mechanical Engineers at their annual meeting, ex-President William Howard Taft opposed the conscription of engineering and medical students. He said that England had made the great mistake of allowing such young men to go to the front, and that she is now greatly embarrassed because of the reduced supply of engineers and physicians. He urged Congress and the administration to see to it that medical and engineering students be reserved for the work for which they are peculiarly fitted, and that these men be required to finish their courses of study before they are gathered into the service. We believe that all broad-visioned men are in accord with Mr. Taft. Why, then, should only "the first or upper third" of our engineering students be exempted from service as provided in a recent order?

Are Concrete Ships Feasible?

A committee report made public last month by the American Concrete Institute gives an affirmative answer to the question of the commercial feasibility of concrete ships for ocean service. Concrete barges for still-water use have been built, but as yet no concrete ship has been navigated in a rough sea where its frame must withstand the stresses developed when it acts as a beam supported between two successive waves, or as a cantilever supported on one wave. The committee says:

> In a steel ship the entire cross-sectional area of the midship section acts to resist these stresses, taking into account, in determining the moment of inertia, all of the continuous members, such as continuous scantlings and deck side and bottom plates. In the concrete ship, equivalent strength must be provided. In the case of the concrete ship, however, only the steel reinforcement can be relied upon to take tensile stresses. The concrete assisted by the steel will take the compressive stresses.
>
> The effect of the rapid change of the character of the stress in either the deck or the bottom is much more serious in the case of a concrete ship than in the steel ship for the reason that, owing to the low tensile stress of concrete, cracks will occur at the extreme fiber under relatively low tensile stresses in the steel. These cracks, if any, alternately opening and closing, may tend to cause disintegration, with resulting leaks or impairment of the reinforcement.
>
> At the present time, little information is available as to the effect of such reversal of stress, and but little can be hoped for until an actual trial has been made of a concrete ship in a sea.
>
> There is an almost unanimous opinion among naval architects and seafaring men generally that a concrete ship will be so inelastic that she will tear herself to pieces in a sea. While it is doubtless true that in a concrete ship there will not be the same readjustment of stresses as in a steel ship when subject to the action of a heavy sea, experience with reinforced concrete structures generally has shown that such structures have considerable elasticity and there is ample reason for the hope that reinforced concrete will prove a suitable material for shipbuilding purposes.

Although it is conceded by the committee that a thin layer of concrete does not afford perfect protection to the steel against corrosion by salt water, the committee believes that if the reinforcing steel is galvanized and covered with carefully made concrete well waterproofed, there should be no serious danger from corrosion.

A concrete hull designed to carry a load of 2000 tons (or "dead weight") and having a displacement of 3675 tons is estimated to cost $126,000, or $63 per ton of dead weight. The cost of a similar steel hull would be $90 to $120 per ton of dead weight and that of a wooden hull $70 to $100. The committee sums up by saying:

> Your committee feels that it is not its function at this time to prepare any detailed plans for a concrete vessel. It is manifestly impossible to design a type of vessel that will be applicable to all classes of service. A barge for use on the canals of New York would not be an efficient type for use in harbors or on the Ohio or on the Mississippi.
>
> Vessels heretofore built have demonstrated that the small barge for still water service can be built and successfully operated. The solution of the larger problem of a concrete ship will include the solution of smaller vessel problem, in which questions of strength are not of the same prominence.
>
> Although there are some questions regarding the concrete ship which can only be answered by actual experiment, the studies which your committee has made point to the commercial success of the concrete ship.
>
> Your committee suggests that specifications for a concrete vessel should embody the following principles:
>
> 1. Both cement and aggregates should be selected with great care to insure a concrete of maximum efficiency.

2. That concrete should be placed in one continuous operation to insure monolithic construction. The concrete mixture should be such as will develop a crushing strength in excess of 3000 lb. per sq. in. when tested in standard cylinders at 28 days. A concrete consisting of one part Portland cement, one part sand and two parts ½-in. aggregate may be expected to give such a concrete. The mixture and workmanship must be such as will assure impermeability.
3. The reinforcing steel should be in the form of deformed bars and should be galvanized.
4. In parts of the vessel where cracks in the concrete would tend to cause leaks, the stress in the steel should be kept low (perferably less than 12,000 lb.).
5. Some form of elastic waterproofing coating should be applied to the hull below the deck.

Loss of Illuminating Efficiency Due to Dirty Reflectors of Indirect Lighting Systems

Davis H. Tuck, Illuminating Engineer of the U. S. Public Health Service, states that the usual indirect lighting system deteriorates 50% in efficiency during its first year, due to lack of proper maintenance. He allows a factor of safety of 25% for the fall in illumination between periods of cleaning of reflectors and ceilings. One of the greatest objections to indirect lighting is the difficulty of keeping the reflectors clean. They are natural dust traps. But if it becomes known that a great loss of illuminating efficiency results where reflectors are dirty, probably systematic cleaning at frequent intervals will become more common. Light-colored walls and gas-filled lamps have greatly reduced the cost of lighting. A still further reduction in cost can be effected by keeping the reflectors clean.

An Economic Combination of a Concrete Frame and a Wooden Floor

An old standard type of floor construction, still extensively used, consists of cast iron columns and steel girders on which rest the wooden joists supporting the flooring plank. The high cost of iron and steel naturally leads to the substitution of reinforced concrete in place of the cast iron and steel. L. J. Mensch, engineer and contractor, Chicago, is using concrete columns of the von Emperger type supporting concrete girders that carry wooden joists and floor. The concrete columns have a cast iron core and a reinforcement of spiral steel hooping. The cast iron core projects up through the floor about 2 ft. into the next column above. The top of the concrete girder is level with the top of the timber floor joists which rest on the offset or wider part of the concrete girder. For warehouse construction and the like, this design is economic under present conditions.

A Suggestion for Protecting Green Concrete from Freezing in Buildings

Coke-burning salamanders are commonly used to heat the walls and floors of concrete buildings. In such cases it is frequently advisable not to attempt to heat all the air in the building, but only the air adjacent to the concrete surfaces. To do this, canvas curtains may be hung parallel with and close to the walls, and salamanders placed between the curtains and the walls. Similarly, a tarpaulin may be laid over horses standing on the floor, and salamanders placed on the floor. Likewise, although we do not know of its having been done, a canvas could be suspended just below the ceiling and salamanders hung between the canvas and the ceiling. In short, the object should be to use canvas in such a way as to confine the heat of the salamanders to the concrete surfaces.

132 Shipyards Are Building an "Emergency Fleet" of 1,427 Vessels

E. N. Hurley, chairman of the shipping board, has stated that there are now under contract 1,427 merchant vessels for the "emergency fleet," totaling 8,573,000 tons of "dead weight." The work is being done in 132 shipyards. Only 15% of the tonnage consists of wooden vessels. One reinforced concrete ship of 4,500 tons is being built in San Francisco with the board's approval, as noted elsewhere in this issue.

The Economy of Using a Concrete Mixer for Lime Mortar for Brickwork

Building contractors are not generally aware that by the use of a small (⅓ cu. yd.) concrete mixer operated by two men, enough lime mortar can be mixed in an hour to supply 16 brick masons for a day. If mixed by hand, the same gang would keep 2 to 3 mortar mixers busy all day. In using a mixer the best plan is to give the lime mortar a preliminary mix by hand in a mortar box. Half the mortar for a day's run is mixed in the machine in the morning and the rest after noon. It is estimated that the tempering of hand-mixed mortar consumes about 10 per cent of a mason's time, all of which can be saved by machine mixing. Moreover, since machine mixing is more thorough, less lime is required than with hand mixing.

The "Roll of Honor" of the American Society of Civil Engineers

In the November Proceedings of the American Society of Civil Engineers is a list of 575 names of members who are serving in the army or navy of the United States or any of its allies. Since the list was published more than 150 more names have been sent in, so that already nearly 9 per cent of the entire membership of this society is enlisted for war service. When it is borne in mind that most of these men are well over the draft age limit and that nearly all of them have volunteered for service, this is a record to be proud of. It is also signficant of the importance of the civil engineer in war.

Casting Smooth Concrete Blocks Face Down in Iron Forms

The problem of economically securing concrete building blocks having smooth surface was solved by the Hanson Bros. Co., Chicago, as follows: In the bottom of each wooden mold is laid a perfectly clean, smooth piece of galvanized sheet-iron. The facing of the block is then laid upon this sheet-iron bed and well tamped. This face is 1 in. thick, made of 1 part stone screenings, 1 part sand and ¾ part cement, mixed with only enough water to make it stick together when gripped in the hand. Upon this facing is laid a reinforcement of wire mesh, and then upon this is placed a 1:2:4 concrete in which are embedded two wire loops to be used in lifting the block. The side forms are held by wedges in a frame, and are removed as soon as possible—2 hours or longer, depending on the weather.

High Carbon vs. Mild Steel Reinforcing Bars

Among structural engineers there is a difference of opinion as to the relative merits of high-carbon and mild steel for concrete reinforcement. This cleavage of opinion was well shown in the discussion of the report of the Am. Soc. C. E. Committee on Concrete and Reinforced Concrete by L. J. Mensch, who said:

> The writer is greatly surprised that this conservative committee allows a stress of 16,000 lb. per square inch on mild reinforcing, without specifying that it should apply only to properly twisted bars, or otherwise to state, like the French committee, that this ruling is on account of the demand of practice (high-carbon steel bars are not a commercial article in France), and that it really results in a factor of safety of considerably less than 3 with the best of workmanship. No mention is made of the use of high-carbon steel bars, and it can be stated positively that the commercial high-carbon steel bars (even re-rolled bars) can be stressed to 26,000 lb. per square inch to give the same strength in a reinforced concrete beam as mild steel bars stressed to 16,000 lb. per square inch. No ruling which the committee has made is so discordant with general practice and will be so generally disregarded as the deliberate omission of high-carbon steel bars, and it positively damages the industry. The writer is well aware that structural steel designers with little experience in reinforced concrete are all in favor of the committee's ruling.

This dispute is one that the Committee might have ended for all time, had sufficient funds been available for experimental tests. Unfortunately, it remains the habit of our American engineering societies to limit the expenditures of committees to such an extent that relatively little research work can be done. Would it be unethical or undignified to solicit subscriptions from manufacturers and others for research work to be conducted by such committees?

235 Miles of Pipe in One Office Building

The cold water, steam, gas and vent piping in the Equitable Bldg., New York City, totals 235 miles of National tube. Some conception of the magnitude of this piping system is had when it is realized that a city of 60,000 inhabitants ordinarily has no greater mileage of water pipe than 235 miles. And, again, the length of this piping is about equal to the distance between New York and Boston.

While it is true that the Equitable Bldg. is the largest office building in the world, accommodating 15,000 tenants in its 38 stories, the amount of piping in any large office building is so great as to be a matter of serious economic concern to the structural engineer who designs the piping system.

Loading Stone and Sand Into Hand Buggies from Bins

The two-wheel buggy has largely displaced the wheelbarrow for handling concrete, but the wheelbarrow still remains in extensive use for delivering sand and stone to mixers. A buggy holds 5 or 6 cu. ft., and one man can readily push such a load over a good plank runway. Frequently it is desired to place the mixer at same distance from the stock piles, in which case buggies are usually more economic than wheelbarrows. If a locomotive crane and clamshell are used to unload cars, bins should be provided, for the aggregates can then be drawn off into buggies without the necessity of shoveling. Of course stock piles are necessary even where bins are thus used, but the clamshell needs to work only a short time each day to keep the bins full.

Pulling "Key Piles" With Hydraulic Jacks

In removing the steel sheet-piles of a cofferdam, the first pile pulled—the "key pile"—is obviously the most obstinate, sometimes requiring a 200 ton stress to start it. In pulling "key-piles" from a cofferdam of Carnegie piles at Troy, N. Y., several methods were tried, and the best of these was found to be the hydraulic jack method. To the "key pile" was bolted, with five 1¼ in. bolts, an extension pile 4 ft. long. To this extension pile, and opposite sides of it, were riveted two 15-in. I beams 3 ft. long, against which the hydraulic jacks pushed. The two jacks—each of 150 tons capacity—stood upon brackets bolted to the two piles on opposite sides of the "key pile." Pulling a "key pile," including the time spent in getting ready, took 1 to 3 days. Then the remaining piles were pulled with tackle and shear legs on a scow, at the average rate of 12 piles in 8 hours. Nearly 3,200 piles were pulled from cofferdam cells that were 20 to 40 ft. deep.

Casting Concrete Piles in Tiers

In making a large number of concrete piles, not only will yard space, but the cost of handling materials be reduced by casting the piles in tiers or layers. For example, some 1,300 concrete piles about 75 ft. long were recently made for piers in San Francisco. The yard was 85x900 ft., and the piles were poured in four successive layers at the rate of about 100 cu. yds. per day. The piles were 18 to 20 in. square, and were cast in wooden forms, side by side, with wooden spacers 3 in. wide every 2 ft. between adjacent side forms. After a layer of piles had hardened, these spacers were pulled out, and the side forms removed to be used again for the next tier of piles. Gantry cranes with chain blocks were used for handling the "cages" of reinforcing rods and placing them in the forms. A crew of 14 men made about 20 "cages" a day.

Concrete Ship Building in Scotland and Denmark.—According to a recent consular report, the Caledon Shipbuilding Co. has accepted a site from the Dundee Harbor Trust of Dundee, Scotland, on which to establish a yard for constructing concrete ships. The site includes approximately 14 acres, situated near the fish docks, and will be put in condition by the harbor trust immediately for the commencement of work on the building of the shipyard by the Caledon company. A consular report also has stated that the building of concrete ships is to be started at Sundby, a suburb of Copenhagen, by a new concern headed by Bagger-Sorensen and Gleerup-Moller. The company has a capital of from $400,000 to $500,000 and intends to build ships up to 1,000 tons.

Structural Features of 130 Ft. Tower of New Pennsylvania Freight Station in Chicago

By JOS. E. LOVE,

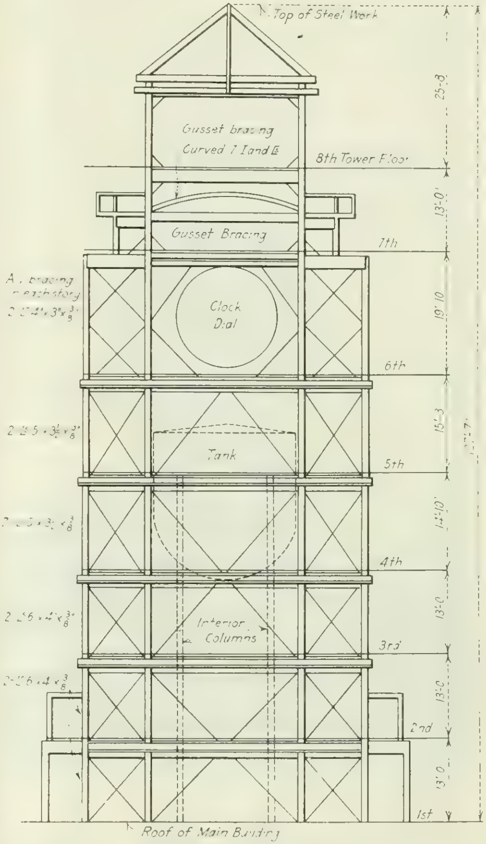
Assoc. Western Society of Engineers.

A rather unusual and yet ornamental and attractive feature of the new $4,000,000 Pennsylvania Co.'s freight station now nearing completion in Chicago is a large steel-frame tower, which besides adding to the imposing architecture of the building serves the useful purpose of carrying a fire service tank and of housing a large clock. This freight terminal, 420 ft. by 750 ft. in plan and 5 stories in height, will be the finest and one of the largest in this country when finished. Loading platforms and 19 tracks depressed below the street level are on the first floor; the team driveways, trucking platforms and offices occupy the second, or street floor, while the three upper floors are for freight storage. An ultimate installation of 50 electric elevators will handle the freight between floors.

The tower, located centrally on the north, or Polk St. face of the station, rises 190 ft. above the street level, or 130 ft. above the roof of the main portion of the building, and is divided into eight stories. The steel fire-service tank of 50,000 gal. capacity is between the fourth and sixth floors of the tower and the clock with its four 16-ft. dials is located in the 19-ft. story above the sixth floor. The first three floors will be used for the filing of records and for similar purposes. Access to the tower may be had by means of a high speed electric passenger elevator in addition to a stairway. The lower 7 tower stories are octagonal in shape with alternate faces approximately 28 ft. and 11 ft. long. Between the 7th and 8th floors is an inset balcony for architectural effect and from this height to the pyramidal roof the tower is 30 ft. square.

The Steel Frame.

Because of the variations in the tower sections and of the different uses for the floors no great uniformity could be secured in the steel framing except in two of the stories below the base of the tank. Though offering no novelties, the design and details of the steel work furnish several points of considerable interest to the structural engineer.

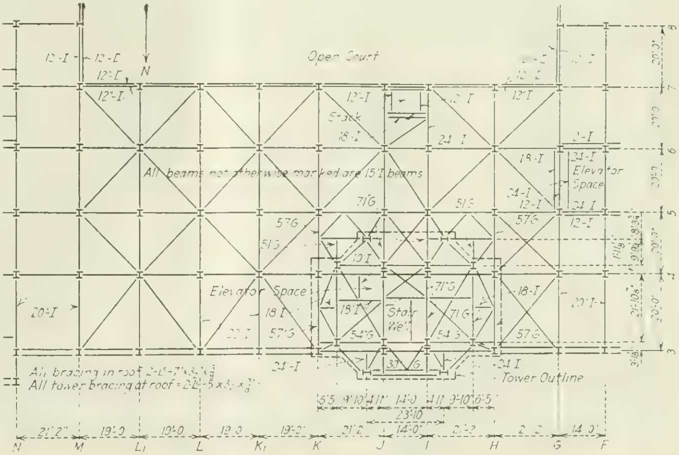


Elevation of Tower Showing Wind Bracing and Location of Clock and Water Tank.

All of the eight exterior tower columns extend to the seventh floor, while the four interior columns are offset by means of 60-in. girders at the fifth floor in order to secure the necessary 24 ft. square clear space for the clock mechanism at the next level. Two of the exterior columns are continuations of the main building columns, but the balance have their loads transmitted to the building columns at the base of the tower through a system of heavy girders varying from 51 in. to 71 in. in depth.

All columns are of built-up H-section, using a 14½-in. web with four 6x4-in. angles and 14-in. cover plates where needed. Floor girders for the first tower floor are mainly the heavy column offsetting girders, while for the other levels the interior framing consists of various sizes of I-beams and built-up girders as indicated on the accompanying plans.

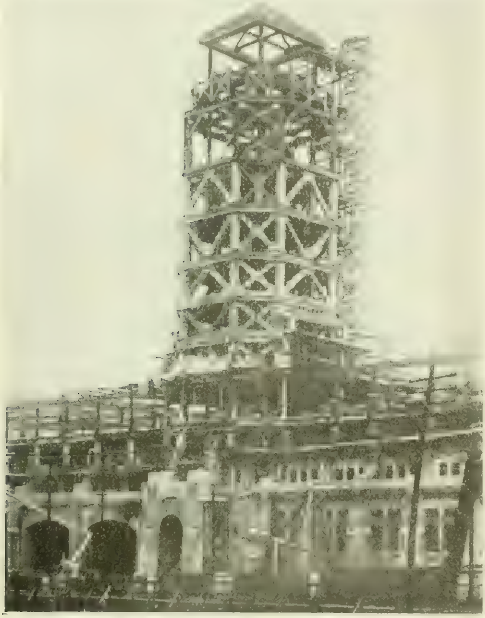
The outside columns are tied in at every floor by a



Part Roof Framing Plan Showing Horizontal Wind Bracing.

line of 30-in. girders, and paralleling each of these girders and bracketed to the columns is a 15-in. channel with a 3½ by 3 by ⅜-in. bottom shelf angle to carry the brick curtain walls.

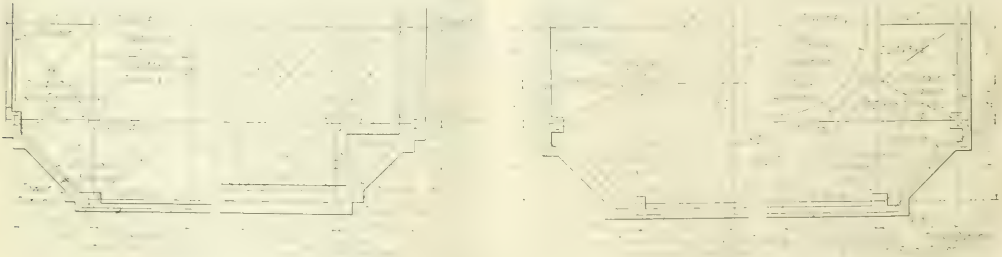
In the fourth and fifth floors, respectively, openings 13 and 22 ft. in diameter were provided for the tank, whose load is transmitted to the interior columns at the fifth floor by 24-in. and 54-in. girders. The balcony framing is supported by the extensions of the inside columns and by short columns which rest on 30-in. girders as shown in the plan of the seventh floor. Above the balcony the main members were 12 to 24-in. I-beams.



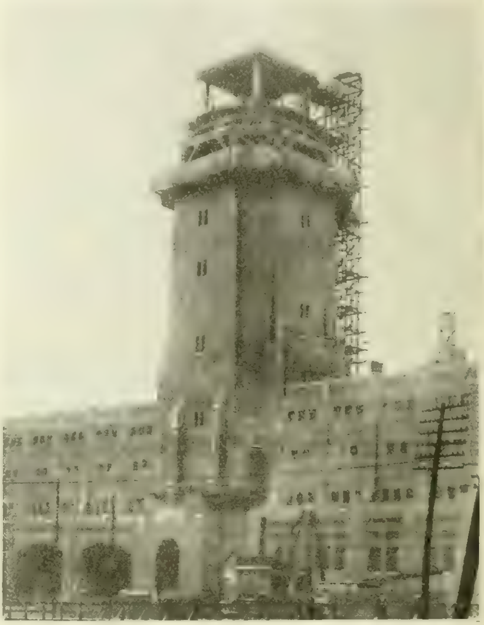
Steel Frame Completed and Partly Enclosed in Forms for Concreting.

Wind Loading and Bracing.

As required by the building ordinances of the city of Chicago the steel frame was designed to withstand a wind pressure of 20 lb. per square foot of tower surface. To care for this, diagonal bracing connected by large wing plates to the exterior columns was used wherever possible. Except at the clock level this bracing was 1-story high on the 11-ft. face and 2 stories high on the 28-ft. face. Between the 6th and 7th floors a double tier of diagonals was set on the short side with knee braces around the clock dials. This double tier and the knee braces offset the omission of diagonals in the long face where their use was prevented by the clock. Gusset plates constitute the wind bracing above the 7th floor.



Typical Quarter Plans of Steel Frame Tower.



Tower Near Completion: Curtain Walls Bricked Up to the Clock.

As carrying the diagonal bracing in a vertical plane down through the building was objectionable, a horizontal system of diagonal bracing was placed, as indicated by the roof plan, in a portion of the roof framing so as to produce a truss action and distribute the stresses into the main framing throughout the length of the building. Wind forces across the face of the building are resisted by gusset plates in the main girder connections to the columns. The horizontal bracing in each tower level consists of single 4 by 3 by ⅜-in. angles except above the sixth, where ¾ and ⅞-in. diameter rods are sufficient.

The outside finish of the tower, which is in harmony with that of the rest of the building, is of light red pressed brick and light yellow terra-cotta trim with a green tile roof. The triangular roof slabs and all tower floors are 4½-in. reinforced concrete slabs. To comply with fireproofing requirements every member of the tower's steel-frame was separately encased in concrete as described in the issue of "Engineering and Contracting" for Nov. 21, 1917.

The design and construction of the freight station was under the direction of Mr. Thos. Rodd, Chief Engineer, and Mr. Robert Trimble, Chief Engineer Maintenance of Way, Pennsylvania Lines West. The Geo. A. Fuller Co. is the general contractor.

Method of Cutting off Reinforced Concrete Piles

An easy and economical method for cutting off the tops of reinforced concrete piles is described by Civil Engineer Kirby Smith, U. S. Navy, in the October Public Works of the Navy. The method was used in connection with the work of roofing over Tingey St., between buildings 23 and 32 in the U. S. Navy Yard, Washington, D. C.

The columns carrying the roof are to be supported by precast reinforced concrete piles located on each side of the street and adjacent to the walls of the existing buildings. These piles are 40 to 45 ft. long, 10 in. square at the point, 18 in. square at the butt, and reinforced with eight ¾-in. square rods tied together with ⅜-in. wire hoops 2 in. center to center for a distance of 3 ft. from each end and 8 in. center to center between these limits. They were cast outside the yard on a vacant lot, picked up by a wrecker crane and hauled to the site on a flat car drawn by a yard engine.

These piles were then driven in place by a 5,000-lb. hammer. Some of them, driven to refusal, projected from 3 ft. to 20 ft. above the required elevation for the footings to rest upon them. This was probably due to the points encountering a stratum of rock. To cut off the piles at the proper elevation the following simple but effective method was used.

Outside the reinforcing rods there is a protective concrete covering of 2 to 2½ in. This was chipped off at the required level with a bull chisel and a sledge, leaving the rods exposed. An air drill was tried, but the chisel and sledge method was found to be easier. Then the rods were cut with an acetylene torch. This left the concrete core, which had a low tensile strength. Where the projecting pile was of sufficient length to give good leverage, a 1½-in. manila rope was slung around the top of the pile and four men pulling on the rope snapped the pile off at the cut. Where the projecting portion was short, the same result was accomplished by a direct pull from the stationary engine on a ⅞-in. steel cable attached to the top of the pile. Two men were employed in cutting out the concrete and four men to snap off the piles. The average time for each pile was one hour and the total cost per pile averaged 60 ct.

A bill has been introduced in Congress under which the government will organize a stock company, holding its entire stock for the purpose of constructing locomotives, cars and other rolling stock and leasing them to the carriers at reasonable rates. The members of the Interstate Commerce Commission would serve as directors, with the Secretary of the Treasury as ex-officio member. The bill provides for an initial capital stock of $100,000,000, to be expanded to $500,000,000 if necessary.

"Cost Plus" Contract Forms of Fred T. Ley & Co., Inc., Hurley-Mason Co. and Ferro Concrete Construction Co.

Among the larger contracting firms in this country that carry out practically all their construction undertakings under "cost plus a fixed sum" or "cost plus a percentage" contracts are the Ferro Concrete Construction Co., Cincinnati, O.; the Hurley-Mason Co. of Tacoma, Wash., and Fred T. Ley Co., Inc., of Springfield, Mass. The last mentioned concern did over $9,000,000 worth of work last year, nearly 90 per cent of which was done on a "cost plus" basis. Of this work 75 per cent was for clients for whom the firm had previously handled contracts. This year the Ley Co. will execute contracts aggregating over $20,000,000, practically all of which is done at "cost plus." The Hurley-Mason Co. undertakes work only under the "cost plus" basis. The Ferro Concrete Construction Co. two years ago did not do over 10 per cent of its work on "cost plus fixed sum" or "percentage" basis. Now practically all of its work is on this basis. This firm at present is doing some work on a flat contract basis, due a good deal to the fact that the buildings are now wanted so quickly that the contractors started on the construction before plans had been advanced far enough by the architect to make any sort of an estimate.

The main features of the 'cost plus a fixed fee" contract forms of these three companies are reprinted below. The forms employed by Fred T. Ley & Co., Inc., follow, in the main, the American Institute of Architects' standard form of agreement. The standard form of the Institute covering the general conditions also is made a part of the contract.

Building Contract Form of Ferro Concrete Construction Co.

Article I.—The Contractor shall furnish all material, tools and equipment and perform all labor for the construction of *

Article II.—The Owner shall pay the Contractor the actual cost of the work plus a fixed sum of †

It is agreed that the fixed sum shall be paid in monthly installments equalling .... % of the cost incurred, the final payment to be paid within thirty (30) days after the completion of the work.

Article III.—The Owner shall pay direct or advance to the Contractor, as needed, sufficient funds to pay the actual cost required for the work, including materials and supplies; the wages and salaries of all employes connected with the work; telephone and telegraph charges; sub-contracted work; royalties or charges, by others, for use of patents embodied in the construction; permits, fees; fees for associations regulating labor difficulties; engineering, drafting, cost-keeping at or away from building site; the premium on liability, compensation or other insurance, and on bonds; small tools and rent on equipment as per attached list; repair of tools and maintenance of equipment; freight, expressage and cartage on materials and equipment used in or for the work including return charges; traveling expenses of all employes and officers of the contractor incurred in connection with this contract; expense of car tracing or expediting the delivery of material and such other incidental expenses, liability or outlay incurred or sustained in the actual execution of this contract.

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*Under this article the Ferro Concrete Construction Co. gives a description of the buildings or any other points that are necessary, sometimes inserting the price of entire material which it furnishes from stock or warehouse.

†Regarding Article II, Mr. Tyler Field, vice-president and treasurer, writes: "Under article II, in some cases we have made an agreement on the 'cost plus fixed sum' contracts that if the cost of labor or materials should be increased above the prices now current and not due to the neglect of a contractor, that the sum mentioned shall be increased, as the intent of either a 'cost plus fixed sum' or 'percentage' contract is that the owner shall pay the actual cost plus a reasonable fee. There is no reason why this clause should not be inserted in the contracts, particularly at this time when changes in labor and material have been so rapid."

Labor, exclusive of carpenter work, done in the main shops of the contractor shall be charged for at 80 ct. per hour, which will include the use of power machinery, etc., in said shop.

Where material is taken from the Contractor's stock, same shall be charged at the prevailing market price for such stock material.

All lumber, small tools, unused material, etc., remaining at the end of the job, shall be sold, or a fair credit made for same by the Contractor, and the actual cost of the work reduced accordingly.

The fixed sum shall include the Contractor's profit, the salaries of all executive officers of the Contractor—meaning the President, Vice-President, Treasurer, Secretary, Auditor or General Manager—also the home office expenses at Cincinnati, except such items as are particularly included in the above.

Article IV.—The Contractor will furnish, on request, schedules of the materials necessary for the work covered by this contract and will submit, on request of the Owner, the prices at which it can obtain any such materials. The Contractor will purchase said materials unless notified, in writing, that the Owner desires to purchase direct, it being understood, however, that such miscellaneous purchase, or purchases, which it is necessary to make at once to insure the speedy and economical carrying on of the work, will be made direct by the Contractor.

Article V.—Should the Owner wish to increase the extent of the work, the Contractor agrees to perform the extra work, and the Owner agrees to pay therefore as provided for work under this contract, the Contractor's fixed sum being increased by .... % of the estimated total cost of such extra work.

Article VI.—It is mutually agreed that in case of any disagreement in the execution of any part of the work, or the misunderstanding of any part of this Agreement, such matter in dispute is to be referred to three arbitrators; one to be appointed by each party to this Agreement, and the third by the two first chosen, the decision of any two of whom shall be final and binding, and each of the parties hereto shall pay one-half of the expense of such reference.

Contract Form of Hurley-Mason Co.

First. The Contractor agrees to erect for said Owner the said building on said premises in accordance with the approved plans and specifications therefor; and it is understood and agreed that only such plans and specifications and drawings of said building as have been approved by the parties, and have been identified by them, and are made a part hereof for reference, shall be considered the plans and specifications for said building, and that said contractor shall erect said building in accordance therewith; and all work in the construction of said building is to be done under the direction and with the approval of said Hurley-Mason Company.

Second. The Contractor agrees to take charge of the work as soon as the premises are ready, and agrees to prosecute the several parts of the work in their respective order with the utmost speed consistent with economy and good workmanship.

Third. The Owner shall pay for all materials used and all labor performed in constructing said building, as is hereinafter provided; but the Contractor shall have the right to enter into contracts for and on behalf of and in the name of the Owner for the purchase of all necessary material and the hiring of necessary labor for the construction of said building; but all contracts for the purchase of materials shall be approved by the Owner, excepting that this provision is not intended to restrict the ordinary purchase of material, the cost of which does not exceed the sum of .... Dollars for which class of material the Contractor shall be allowed to purchase without previous authorization. A signed copy of all contracts or agreements entered into by the Contractor for the purchase of materials shall be filed with the Owner.

Fourth. It is understood and agreed that the Contractor shall have full power in the management of the construction of said building and in the purchase of all material therefor and the employment of all labor required therein and also to make all necessary contracts in connection with the construction of said building; but the Contractor shall first procure the permission from the Owner in writing before sub-letting any portion of the work under this contract or before entering into any contract for the purchase of material except as specified in Article Three.

Fifth. The Contractor agrees to build all necessary fences, runways and ladders; to secure and pay for all necessary permits and licenses; that all work performed is to be according to the ordinances, rules and regulations of the City of ....; to conform in all respects to the provisions of the Inspector of Buildings and the Building Department of said City; to take all reasonable precautions to protect both private and public property from damage thereto and in case damage occurs to either, to repair same; to remove rubbish from said premises from time to time and keep the building clean; to take proper precaution to protect all work and material from damage until delivery to and acceptance of the building by the Owner; to comply with the State's Industrial Insurance Law in making proper returns; to supply a competent superintendent to represent the Contractor in the performance of said work at all times; and to provide all necessary watchmen and signal lights to guard the property of the Owner and the public against accidents. All policies of insurance or bonds secured by the Contractor for the benefit of the Owner directly or indirectly shall be taken from companies subject to the approval of the Owner, and shall be subject to inspection at all times. The expense of the above items shall be borne and paid by the Owner as a part of the cost of said building.

Sixth. The Contractor will not permit any advertising on said premises or the portion of the streets abutting the same.

Seventh. The Contractor agrees to and does hereby guarantee the workmanship performed under this agreement, and should any defect patent or discoverable by the use of reasonable care and a reasonable test be discovered within one year after the acceptance of the building by the Owner, which defect is due to faulty construction, the Contractor will be responsible therefor and make same good without expense to the Owner.

Eighth. The Contractor will furnish without charge other than the fee herein provided for, its business system, its engineering skill and experience, its skilled organization, and generally, its ability to equip the work with sufficient plant, and to organize the job with men experienced in this class of work.

Ninth. The Contractor agrees to furnish plans and specifications necessary to the proper construction of building.

The Contractor will also furnish without additional charge the heavier items of the plant required in connection with the work, such plant consisting of engines, motors, mixers, hoists, derricks, booms, carts, forges, pneumatic riveters, reamers, pressure tanks, and other heavy appliances.

The Contractor will include in the cost of the building the following items:

The actual cost of all material and labor, together with the cost of testing same.

The actual cost of a superintendent of construction; a timekeeper and a material clerk.

The actual cost incurred in the delivery and removal of materials and tools and contractor's equipment.

The actual cost incurred in the equipment and the expense of operation of the temporary office at the building site.

The actual cost incurred on liability bonds and permits.

The actual cost of operation, maintenance and repairs to Contractor's equipment while on the work.

The actual cost of supplies and all small tools necessary for the use of the workmen not supplied by themselves, any salvage on same at the completion of the work to be credited to the Owner.

It shall be the right and duty of the Contractor to remove from the building site all tools and equipment when in the judgment of the Contractor they are no longer needed.

Tenth. The Contractor will, if required by the Owner, furnish a satisfactory bond conditional on the faithful performance of the terms and conditions of this agreement. The cost of such bond to be paid by the Owner.

Eleventh. The full compensation or fee of the Contractor for the performance of all terms and conditions of this contract shall be .... ($................) Dollars, which will not vary with the actual cost of the building.

The Owner agrees that between the first (1st) and tenth (10th) day of each month he will pay, or cause to be paid, to the Contractor on account of the commission herein agreed upon, ... per cent of said commission until eighty per cent of the commission has been paid, the balance to be paid within thirty (30) days after the completion of the work.

Twelfth. The Owner hereby covenants and agrees to well and truly pay, or cause to be paid, the necessary cost of said building in the following manner.**

(a) On or before the fifth day of the month the Contractor will approve all bills, except labor payrolls, and turn same over to the Owner who will issue a check to the Contractor in payment of same on or before the eighth day of the month, so as to permit discounts being taken by the 10th. Payrolls for labor will be rendered to the Owner weekly and the amount of said rolls is to be paid to the Contractor within three days thereafter.

(b) The Contractor will prepare a statement of all bills contracted during the preceding month, except labor payrolls, and render same with the Contractor's approval on or before the eighth day of the month so that the Owner may pay same direct. Payrolls for labor will be rendered to the Owner weekly and paid directly by him.

(c) On the first day of the month the Contractor will issue a request to the Owner for a specified sum of money necessary

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**The two methods of payment not adopted are crossed out.

to pay the bills for current expenses, and upon receipt of same on or before the sixth of that month, the Contractor will pay all such bills and render a statement by the twentieth of that month, showing a full account of moneys received and expended, together with receipts for such expenditures.

Thirteenth. All possible rebates and discounts shall be secured and accounted for by the Contractor and shall inure to the benefit of the Owner.

Fourteenth. The Contractor agrees to furnish to the Owner whenever required to do so, a full statement of all moneys expended in the construction of said building, all moneys due thereon and an estimate of the amount required to cover the cost of the work which at any particular time may not be completed. The Owner shall at all times be permitted to inspect all payrolls, contracts or books of the Contractor insofar as they relate to the performance of said work. Records necessary for this purpose shall be kept in the City of .... so access may be had to same at any time.

Fifteenth. In the event of the Owner and the Contractor being unable to agree in relation to the construction of any of the provisions of this contract, such disagreement shall be referred to and be decided by two arbitrators, one being selected by the Owner and the other by the Contractor, and in case the two so elected cannot agree, the two arbiters so chosen shall select a third and the decision of any two of the three shall be final and binding upon the parties hereto concerning the construction of said contract. The arbitrators' decision shall be made in writing, a duplicate copy of which shall be delivered to each party. The expense of such arbitration to be equally borne by the parties hereto.

††Sixteenth. The Contractor guarantees that the total cost of this building including its fee, according to the plans and specifications made a part hereof, shall not exceed the sum of .... ($...... ....) Dollars, and should the cost thereof exceed this sum, the Contractor agrees to complete the building according to the plans and specifications as have been approved and to stand such additional cost without further obligation on the part of the Owner.

In case changes in the plans and specifications are required by the Owner, necessitating extra expense in the construction of the building, the Owner will be responsible and pay therefor, notwithstanding the foregoing guaranty, but no additional fee is to be paid the Contractor on account of said changes.

Seventeenth. It is understood and agreed by the parties hereto that all the covenants and agreements contained herein shall extend to and be obligatory on the heirs, successors, and personal representatives of the parties hereto. There shall be no assignment whatever of this contract, either voluntary or by operation of law.

Contract Form of Fred T. Ley & Co., Inc.

Article 1. The Contractor agrees to provide all the materials and to perform all the work shown on the drawings and described in the specifications entitled .... prepared by .... acting as, and in these Contract Documents entitled the Architect, and to do everything required by the General Conditions of the Contract, and the Specifications and the Drawings, so far as consistent with the provisions hereof and with the General Conditions of the Contract.

Article 2. The Contractor agrees that the work under this Contract shall be substantially completed as soon as reasonably possible; it being expressly understood and agreed that the Contractor shall not be liable in any event for any failure to perform or any delay in the performance of this Contract caused by or resulting from the withdrawal of men or materials or the failure of the Contractor to supply either thereof by reason of work required to be performed by the Federal or any State Government or under the laws of either thereof.

Article 3. The Owner agrees to pay the Contractor in current funds for the performance of the contract, the Actual Cost of Construction as hereinafter defined, plus a fixed fee of .... Dollars as the Contractor's compensation for the execution of the work herein called for, and to make payments on account thereof as follows:

On or about the first day of each calendar month the Contractor shall render to the Architect a detailed statement of all charges in connection with the work as hereinafter specified as the Actual Cost of Construction, with an additional amount of .... per cent added thereto as part payment of the Contractor's compensation, and not later than the fifteenth day of each calendar month the Owner shall pay the Contractor the full amount of such detailed statement as approved and upon certificates issued by the Architect; or, on appeal, by the Arbitrators as hereinafter provided. Final payment of all charges in connection with this work, together with the full amount of the Contractor's compensation, shall be made within thirty-one days after the completion of the work included in this Contract.

No certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of the work either wholly or in part, and no payment shall be construed as an acceptance of defective work or improper materials.

It is understood and agreed that the fixed fee mentioned above is not subject to change unless the scope of the work is materially changed, in which case it will be increased or decreased by such sum as may be determined by agreement of the parties hereto, or by arbitration as provided in Article 45 of the General Condition of the Contract.

Article 4. The Contractor and the Owner agree that this Agreement together with the General Conditions of the Contract hereto annexed so far as consistent with the provisions of this Agreement and the Specifications and Drawings so far as consistent with said General Conditions and with the provisions of this Agreement, form the Contract; and that the General Conditions of the Contract so far as consistent with the provisions of this Agreement, and the Specifications and Drawings so far as consistent with said General Conditions and with the provisions of this Agreement, are as fully a part of the Contract as if hereto attached or herein repeated; and that the following is an exact enumeration of the specifications and drawings:

Article 5. As the actual cost of construction is made the basis of the payments to be made under this Agreement, all cost and expense properly incurred by the Contractor for the complete execution of the work shall be allowed as due and payable to the Contractor and said Actual Cost of Construction shall include the cost of:

(a) Materials. All materials of every kind purchased for the work (except Contractor's equipment hereinafter provided for), whether for incorporation in the work or for use in connection therewith, as shown on the original invoices for said materials. Materials not incorporated in the work and available for disposal at the completion of the work shall be disposed of to the best advantage and the disposal price credited to the Actual Cost of Construction.

(b) Labor. The actual payments for all labor employed on the work as shown by the payrolls of the Contractor, which payrolls shall include payments of all superintendents, engineers, foremen, timekeepers, stock clerks, cost accountants, on the job, watchmen, mechanics, laborers, and such other labor as may be necessary for the proper handling of the work, and all payments for teams, wagons, motor trucks, rental charges for Contractor's equipment, or hired equipment.

(c) Contractor's Equipment. Rental and other charges for the use of Contractor's equipment are to be made in accordance with Article 6 and special rates for shoring and building mover's equipment will be made should any such equipment be required, also for any other equipment not included in Article 6.

(d) Shoring, Underpinning or Moving. Should shoring, underpinning or the moving of any buildings or structures be required in connection with any portion of the work the rates for labor employed in connection therewith shall be as follows:

Foremen ....$10.50 per 8 hour day
Laborers ....$ 6.50 per 8 hour day

These rates include the Contractor's profit and no additional profit shall be added thereto. The Owner shall assume all responsibility for all claims arising for damages to such buildings or structures during said operations and all legal expenses, if any, in connection therewith, and shall provide the Contractor full and free access to such buildings or structures for said operations and shall hold the Contractor harmless from any and all suits or claims for damages of every kind in connection with said operations.

(e) Expenses. All expenses incurred for the transportation of men, materials and supplies to and from the work and traveling expenses in connection therewith, including the traveling expenses of the General Superintendent in connection with his visits to the work, all expenses for telegraph and telephone, premiums on insurance, including public and employer's liability, workmen's compensation, plate glass and fire insurance; all municipal and other permits, water, gas and electricity, patent royalties, etc., and all other expenses properly incurred for the completion of the work not otherwise specifically provided for.

The Contractor's compensation shall cover the Contractor's profit, overhead, administrative expenses, and taxes, and no further charge shall be made by the Contractor for the services of any officer of the Contractor; nor for the services of any member of the Contractor's general office force at Springfield, Boston, or New York, unless otherwise provided for.

The Owner shall not be entitled to cash discounts on bills for materials supplied unless he deposits with the Contractor from time to time sufficient funds to meet the payment of bills on which discounts may be taken. All funds so deposited shall be credited upon the statement covering the period for which they apply.

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††Regarding this clause, Mr. Charles B. Hurley writes that they are seldom called upon to give any such guarantee and that considering the present state of cost of materials and labor he doubts if it would be advisable for a contractor at the present time to make a guarantee.

The Owner may purchase or furnish any materials required for the work, but should he do so, he shall do it in a manner that will not delay the Contractor in the execution of the work, and any materials so furnished by the Owner shall be considered as a part of the Actual Cost of Construction upon which the Contractor shall be entitled to receive his percentage of compensation as hereinbefore provided.

Article 6. Rental charges, per day, for equipment as mentioned in this contract.

Automobiles—	
6-cylinder closed cars	$15.00
Ford and light 4-cylinder	5.00
6-cylinder	10.00
1,200-lb. Overland deliveries	10.00
Trucks, 2-ton	20.00
Trucks, 3½-ton Duplex	30.00
Trailers, 5-ton Troy	10.00
Buckets—	
Tipple and bottom dump	.25
Orange peel, ¾ and 1-yd	3.50
Orange peel, less than ¾-yd	2.00
Clamshell, 1-yd.	2.00
Boring Machines—	
Pneumatic	.50
Electric	.50
Back filler, power driven	5.00
Boiler and 3-drum engine	3.50
Boiler and 2-drum engine	3.00
Boiler and 1-drum engine	2.50
Boiler only, 30 H.P. and smaller	1.50
Boiler only, 30 to 80 H.P.	2.00
Cars—	
Skip, 1½-yd.	.25
Skip, 3-yd.	.50
Steel, 1-yd. and smaller	.15
Wooden, 4-yd.	.25
Wooden, 6-yd	.75
Wooden, 12-yd.	2.00
Wooden, 1-yd. hopper radial gate	.25
Crusher only	2.00
Crusher with elevator and screen	3.00
Compressors, large sizes, special sizes—	
10x10 with steam engine	2.50
8x8 belt driven	1.00
Small, with gasoline engine on wheels	5.00
Large, with gas engine on wheels	10.00
Westinghouse, 9½-in., single action	1.00
Westinghouse cross-compound	2.00
Counterweight drum	.50
Cutter, bar portable, with motor	2.50
Drill rig, auto traction	10.00
Drill, small air	.50
Drill, steam	1.00
Diving outfit with pump	10.00
Derricks—	
60 to 85-ft. wooden	2.00
30 to 59-ft wooden	1.50
Less than 30-ft. wooden	1.00
Breast	.25
Circle swing	.25
Steel, 80 to 90-ft	3.50
Elevator, platform or bucket	.25
Elevator with bins for concrete	.50
Excavator, Keystone No. 3	30.00
Engines—	
Skeleton, 3-drum	2.00
Skeleton, 2-drum	1.50
Skeleton, 1-drum	1.00
Steam horizontal, 11 to 40 H.P.	1.50
Steam upright to 10 H.P.	.50
Gasoline to 8 H.P.	.50
Gasoline to 10 H.P.	1.00
2-drum with electric motor	4.00
Derrick swinging	.50
Hammers, riveting	.25
Hod elevating machine, hand power	1.00
Leveling instrument, engineer's	.25
Locomotive, 36-in. dinkey	5.00
Locomotive, standard gauge saddle tank	10.00
Mixers—	
With boiler and side loader	4.00
With boiler	3.00
With electric motor to 1-yd.	4.00
Without boiler, less than 1-yd	2.00
Without boiler, 1-yd. and larger	3.50
With gasoline engine	3.00
Motorcycle	1.00
Motors—	
2 H.P.	.15
5 H.P.	.25
10 H.P.	.50
25 H.P.	1.00
50 H.P.	2.00
Other sizes at $1 per H.P. per month.	
Pumps Centrifugal—	
10-in belt driven	3.00
10-in. with motor attached	4.00
8-in. steam connected	2.00
6-in. steam connected	1.50
4-in. steam connected	1.00
Duplex and triplex to 3-in	.50
Pulsometer to 4-in	.50
With gasoline engine	1.50
Diaphragm	.25
Diaphragm with gas engine	1.00
Triplex with belt drive	.25
Pile Hammers—	
Steam, up to 2,500 lb.	3.00
Steam, larger than 2,500 lb.	5.00
Rail, per ton	.10
Roller, horse	1.00
Steam roller	8.00
Steam shovels, revolving traction	30.00
Saw benches, plain	.25
Saw benches, plain, with motor or gas engine	.50
Saws—	
Table, railway cutoff	1.50
Automatic feed	.50
Swing cutoff	.25
Eliot woodworker with motor	1.50
Band, for iron	5.00
Scrapers	
4-wheel road	1.00
Wheel, 1-yd.	.50
Scale boxes	.25
Sprinkling cart	1.00
Trench diggers	30.00
Transits	.50

Article 7. The Contractor shall take all reasonable precautions to protect his own, the Owner's, and adjacent property from injury in connection with the execution of this contract, but does not assume responsibility to make good, without cost to the Owner, work that is defective or damaged and damages to property except such as is the result of negligence—lack of a reasonable amount of care under ordinary circumstance—of the Contractor or his employes. Defective or damaged work for which a subcontractor is responsible shall be made good by the Subcontractor, without expense to the Owner, in accordance with the terms of the Subcontracts.

Article 8. All questions in dispute between the parties of whatever nature the same may be, including the interpretation of the Contract documents, shall be determined as provided by Articles 10 and 45 of the General Conditions of the Contract.

1,427 Ships Now Under Construction or Contract

Interesting information on the progress in shipbuilding in this country was brought out last week at the senatorial investigation of the shipping board, the emergency fleet corporation. Ships to the number of 1,427 of 8,573,108 dead weight tons are under construction and under contract. Of these 996 are new ships contracted for by the emergency fleet corporation and 431 were already under construction for private or foreign owners when the commandeering order went into effect Aug 3. On July 27 there were under contract 840,900 tons of wooden ships, 207,000 tons of composite ships, and 587,000 tons of steel ships. Since then additional contracts amounting to 3,378,200 tons of steel ships and 504,000 tons of wooden ships have been placed. In addition the fleet corporation has rendered financial aid to and is directing the work of extension and development in 42 yards. The remaining new yards are being constructed by private capital. The contracts of the emergency fleet corporation have been let to 110 shipyards, of which 36 existed on Jan. 1, 1917, and 74 have been created since. The emergency fleet corporation has requisitioned vessels which are building in 22 shipyards in addition to the above, so that the fleet corporation is at present controlling work in 132 yards, of which 58 are old and 74 are new.

At a meeting of the Washington Chapter of the American Association of Engineers on Dec. 14, the following officers were elected: F. R. Weller, Consulting Engineer, President; A. S. Grossberg, Chief Designer, Bureau Yards & Docks, First Vice-President; Harry Stevens, Consulting Engineer, Second Vice-President; Capt. D. S. Hays, Engineer Corps, U. S. A., Secretary; O. M. Sutherland, Mechanical Engineer, Bureau Yards and Docks, Treasurer. The total number of members in Washington to date is 100. The Association is a member of the Chamber of Commerce of the United States of America and is co-operating with all the Chambers of Commerce throughout the country.

The Construction of Industrial Villages—A New Field for Large Building Contracts

One of the prime causes for the shifting population and large labor turnover of many industrial plants is the utterly inadequate housing facilities available for the workmen. Some manufacturers have begun to take notice of this fact and as a consequence several extensive housing developments have been undertaken recently. This work has opened up a new field for building contracts, which already is being developed by a number of large contracting organizations. An interesting paper on industrial housing problems, prepared by Mr. Leslie H. Allen of the Aberthaw Construction Co., Boston, Mass., has been issued recently by that company. The following notes are extracted from the paper:

When the manufacturer has decided to build, he is faced with the problem of selecting the type of house he shall build, its size, number of rooms, materials of construction, amount of land per house, and so on. On these subjects there are as many differences of opinion as there are experts studying them.

In order to arrive at some working basis to govern the laying out of new work, it will be well to consider the essential needs of a workman's family in the light of present-day needs.

It must first be recognized that we have two classes of workmen to be considered: (1) The unskilled workmen, mostly foreigners or negroes, uneducated, unused to American houses and American standards of living, earning a very low wage, and (2) the skilled men, mechanics, machinists, etc., earning a higher wage, mostly Americans, living according to American standards, demanding and willing to pay more for the comforts that the foreigner does not consider essential. The result of a failure to distinguish these two classes is that at the present time nearly all the houses built are American houses for skilled workmen, and the need for better houses for unskilled labor has remained unsatisfied, resulting in overcrowding getting worse and worse. Here and there, as in Philadelphia and Washington, a most excellent attempt has been made to solve the problem of housing the unskilled, low-paid workman. Such examples have not been copied, and only serve to show up more sharply the mistakes of other cities.

The essentials of a modern city house may be summarized as follows:

Watertight roof, walls and floors.
Bedroom for parents.
Bedroom for male children.
Bedroom for female children.
Living-room for cooking, eating and general day use.
Private toilet-room with sanitary water-closet and sewer connection.
Suitable heating arrangements.
Running water supply fit for drinking.
Uninterrupted daylight and ventilation through windows in every room.
Sink in kitchen, with running water and waste.

Further additions required by the American family and considered necessary by them:

Cellars.
Closets.
Bathtub with running water.
Window screens.
Separate parlor.

Desirable improvements which usually are added:

Porches and piazzas.
Lavatory bowl.
Hot-water supply to bath and bowl.
Window shades.
Window blinds.
Dining-room separate from parlor or kitchen.
Electric lighting or gas piping.
Wall-paper.
Laundry tubs.

Any attempt such as the above to divide essentials from luxuries must come in for a good deal of criticism, as there is bound to be a difference of opinion upon the details of such a list. The classifications suggested will at least serve to indicate the lines upon which the planning of a house should be studied in view of the need for strict economy in designing and building necessary to bring buildings down to a cost that will be remunerative.

It is generally agreed by economists that the workingman cannot afford to pay more than one-quarter of his monthly wage in rent. This means that the man earning an average of $12.50 a week cannot afford to pay more than $150 per annum. Assuming that a housing operation ought to pay at least 10 per cent gross per annum, this gives $1,500 for purchase of lot with sewer and street improvements and the building of a house. At the present time a 4-room house of good construction cannot be built for this money and it is therefore necessary to plan with the very strictest economy.

The various types of houses now in use are as follows:

(A) Single houses of 5 to 7 rooms.
(B) Two-family houses of 4 to 7 rooms.
(C) Terrace or row houses of 4 rooms and up.
(D) Apartment-houses or tenements, 2 rooms and up.
(E) Boarding-houses for single men.
(F) Hotels.

The single house is the ideal residence for the American family, but is beyond the means of the low-paid unskilled workman. A single house with five or six rooms with 3,000 ft. of land cannot be built for less than $3,000 except in the cheapest kind of frame construction, and even at this price it would call for a higher rental than he can afford to pay. For higher-paid men in the plant the single house is very desirable.

The 2-family house is often built for workers who wish to purchase their home. Though not suitable for the unskilled worker, they are quite attractive to higher-paid men who like to buy a 2-family house so that the rental received from one-half of the house will help to pay the carrying charges and amortization of the whole house. In some cases these are built side by side with a party wall and in some cases one tenement is built above the other. The first-named is preferable, as there is more privacy.

One of the most successful houses for the unskilled worker is that known as the "Philadelphia" type of house, of which many thousands have been built in Philadelphia, Washington, and other large cities. The typical 4-room Philadelphia house is two rooms deep and has a living-room and kitchen downstairs, two bedrooms and bath upstairs. It is built in long rows or terraces with party walls in between. These can be built on as narrow a frontage as 13 ft. 6 in. (a 15-ft. frontage is desirable) on a lot of 900 sq. ft. The cost of both land and building is much lower than the preceding type. Houses built when prices were normal have been rented for as low as $12 a month and have shown a fair profit.

The building of houses in terraces is comparatively new in this country except in Philadelphia, although it is very common in European countries. It allows for a very little land per house unless the lots are very deep, but is desirable in many other ways. Each family has a direct entrance from the street without any common hallway and is not interfered with by other tenants overhead. The cost of heating the house is less owing to there being fewer outside walls. In a house two rooms deep each room has a proper amount of light and ventilation, and these houses have proved very successful wherever they have been used.

A recent variation of this type of house is the 3-room 2-family terrace house with one family on each floor. These are generally in demand by married couples without children.

The multiple dwelling or tenement house, housing from 10 to 50 or more families, is undesirable from many points of view, and yet in crowded cities where land values are high, it is practically the only solution.

Apartments of all sizes can be provided, the most common arrangements being 3 rooms (kitchen, living-room and bedroom), or 4 rooms (kitchen, living-room and 2 bedrooms). Each partment should have its own private toilet and its own water supply.

Although city laws do not in every case require it, multiple dwellings ought in every case to have fireproof stairways and fireproof cellars, and care should be taken to see that every room and also the halls and stairs are properly lighted. In English cities the stairs are often built outside the building and each apartment is approached from balconies. This is in many respects a good way of building, and has been copied here in a few New York City buildings. This type of plan eliminates the common hall and inside stairs, which are frequently dark and difficult to keep clean and supervise.

There is always some demand in a large manufacturing center for small apartment houses of 2 or 3 rooms with bath, etc., for married couples without children. They are not so desirable as homes for the workingman, and yet there are some mechanics who prefer them just as so many well-to-do people in our cities are content with and prefer this class of dwelling.

In rural districts many mills have built small boarding-houses large enough to take care of from eight to a dozen boarders. The advantages of a small boarding-house are that one man and his wife can run them, and the mill has no further responsibility. The men also prefer this sort of lodging to big company houses. The big disadvantage is that it is difficult to exercise any supervision over this sort of boarding-house, and they may be misused or overcrowded. This far outweighs its advantages.

The old style of mill boarding-house or hotel taking in a large number of employes has gone somewhat into disfavor. Under proper regulations this is a much better method of housing than in boarding-houses or by allowing the families to take lodgers, but it is difficult to popularize it among the men. It will generally be found that the single worker prefers to lodge with a private family if he can possibly do so, but if this is impossible or if he is prevented by the owner and can be induced to take up his quarters in a large boarding-house, he can be very comfortably housed at a very moderate cost. One that we have recently built takes care of 60 men at a charge of $1.50 per man per week. This building has a large dining-room and kitchen, etc., board being furnished at moderate cost.

The good points of the boarding-house for 50 to 60 men are that one efficient married couple with three servants can run the place without difficulty. A higher type of tenant is required to handle a proposition of this kind, but they can be secured fairly readily. It is easier to arrange for proper inspection and supervision, as in most cases, these are run as "company houses."

A boarding-house for more than 60 is too big a proposition to be handled this way, and would have to be run like a hotel with a manager and regular hotel staff.

In London (England) and in Liverpool, the Rowton House Trust and other organizations have been operating hotels for 500 or more single men successfully for many years, but up to the present time none have been built in American manufacturing centers.

There should be in every home enough bedrooms for the parents and the children of either sex to sleep apart. A good-sized bedroom should be provided for parents (and infant children) and two smaller bedrooms, large enough to accommodate two persons each for the other children. All families, of course, are not of the same size, and some larger and smaller houses will be needed; but as a rule it will be found that the larger demand is for the 4-room, 5-room and 6-room houses.

It seems to be a matter of habit in many quarters to build nothing but 6-room houses; this is a manifest hardship to those who do not need so many rooms. If a man cannot afford to rent a 6-room house and does not need the accommodations and yet finds that the 6-room house is the only accommodation he can gain, he has to take in lodgers to help pay the rent. From the social standpoint the lodger is generally considered to be a menace and an unmixed evil. We have found that where we built 4-room houses these were often taken up first of all by the employes.

Where houses are built to sell, however, there is not so much demand for the smaller houses and the 6-room house is as a rule the smallest house that one can count upon selling without difficulty.

The size of the bedroom should be sufficient to give at least 400 cu. ft. of air space per inmate. All bedrooms should open onto a hall and not into each other or into a living-room.

Next, there must be provided at least one living-room (having an area of not less than 135 sq. ft.) for working, eating, washing, and general use. There is much controversy on the subject of separate dining-rooms and separate parlors, which add much to the attractiveness of the house, but also to its expense, and it is not always possible to provide them for the unskilled laborer.

The foreigner does not use a kitchen, dining-room and parlor; what he needs is one large kitchen. It is found that where three living rooms are provided, two of them are invariably used as bedrooms for the lodgers. It is the habit of most foreigners and indeed of many Americans to live in their kitchens, and this room should be large and well-lighted and ventilated.

The toilet-room must be planned so that it does not open directly into a living-room or bedroom, but off the stairs if possible.

There is no justification at the present day for the existence of the old-style out-closets or privies. Water-closets connected to cesspools are sometimes satisfactory, but are very undesirable, especially in cities. It is much wiser to figure on the construction of a sewer at the time the house is built, as cesspools, unless properly looked after, are a potential source of danger to the water supply and a menace to the public health.

Some comment will naturally be made on the suggested omission of the cellar. We are told that the family needs a cellar for the storage of coal and canned fruit, and that it costs no more to build it than to leave it out, as the foundation walls are the same in either case. The laborer to too poor to buy more than 200 or 300 lb. of coal at a time, and never lays in stocks of food in advance; instead of this we usually find in his cellar a miscellaneous assortment of most insanitary rubbish and junk, which is not only undesirable but constitutes a serious fire menace. Statistics show that over 80 per cent of dwelling-house fires start in the cellar in such rubbish piles.

The argument that it costs no more is nearly true where sand and gravel soils are encountered, but in clay or other hard digging the extra cost of digging the cellar mounts up considerably. Cellars are not needed for furnaces where the tenant cannot afford the fuel for them but derives his heat from his kitchen stove.

Where the cellar is omitted a space should be left under the floor, ventilated by gratings in the outside walls which can be closed in cold weather.

In houses of this class the tenant usually furnishes his own stove, and as his stove has no hot-water front, a system of hot-water piping is of no use to him. Some owners prefer to install the stove with water front and hot-water piping in spite of the increased cost of the house, but all these things help to put up the cost and the resultant rent to a figure higher than the tenant can afford. For the same reasons washbowls in the bath-room, and laundry tubs, though useful, are not necessities. There should, however, be an enameled iron sink in the kitchen, and a bathtub should be provided even if the tenant has not learned how to use it. There should be a proper supply of running water, pure, and fit for drinking, and a water-closet connected with the sewer, and a cast-iron enameled bath.

Very little change has been made in recent years in construction methods and materials, the chief alteration being towards the reduction of fire risks and conflagration hazards.

The standard form of wall construction for rural districts continues to be wooden framing. Where city laws do not forbid it, this is used in the cities. The frame is usually lathed and plastered inside and covered with rough boarding paper and shingles or clapboards outside. Cement stucco on wire lath is coming into vogue for exterior finish—at a slightly higher cost; this when put on satisfactorily requires less maintenance and no repainting, but requires expert workmen to make a satisfactory job. In a few cities brick walls are more frequently used, furred on the inside and lathed and plastered. A few houses here and there have been built with hollow tile, stuccoed outside and plastered inside directly on the tile; and some experiments have been made in concrete houses, although nowhere yet has Edison's dream been realized. The most noteworthy instance of concrete houses are the hundred houses at Donora, Pa., built for the American Steel & Wire Co. by the Aberthaw Construction Co. These houses, built with Lambie steel forms, have 6-in. reinforced concrete walls, stuccoed outside and furred and lathed and plastered inside. The forms, however, give such a smooth surface that it is intended on the next job to leave the concrete exterior surface bare, rubbing any irregularities and leaving a smooth concrete surface of even texture and color.

Although no exact cost data can be given at the present time on the foregoing material, the following figures are, however, given in order to indicate the relative costs of these materials based on present prices. As prices do not vary consistently, these figures may not hold good for very long. In certain localities where clay for tile-making is abundant the prices of tile would be cheap and would indicate that this is the cheapest material to use. In other places where there is a good gravel supply right on the ground the relative cost of concrete would be reduced.

Assuming the cheapest construction, a wood framing, wood lathed and plastered on the inside and rough boarded and shingled on the outside, as our standard or 100 per cent, the relative costs of various houses would be as follows:

Wood framing, inside wood lathed and plastered, outside rough boarded and clapboarded and painted	102%
Wood framing, inside wood lathed and plastered, outside wire lathed and stuccoed	108½%
6-in. concrete wall, inside furred and lathed and plastered, outside rubbed smooth	112%
6-in. concrete wall, inside furred and lathed and plastered, outside stuccoed	116%
8-in. hollow tile, inside plastered direct, outside stuccoed.	111%
8-in. brick wall, inside furred and lathed and plastered..	115½%
Wood framing, veneered with 4-in. brick, inside lathed and plastered	113%

Until quite recently small house construction has been entirely in the hands of the local builder, operating on a small scale. During the past year, however, with the institution of several large housing developments in which speed of construction and durability of workmanship were important essentials, large contracting organizations have taken up this class of work, so that the manufacturer can now get the same kind of service in his house construction as he has been accustomed to get in his plant construction contracts. A good deal of economy is always gained when a large number of houses are built at one time by one contractor. The money saved by purchasing direct from manufacturing firms in carload lots rather than in team-loads from a local dealer, the continuous employment of large gangs of men, the taking of cash discounts and other economies practiced by big contracting organizations are quite a help in reducing costs.

When the whole development is under the control of one responsible contractor, the disappointments so often experienced of houses built but roads not finished or sewers not completed are avoided. The grade of workmanship is better and the work is finished promptly instead of being allowed to drag far beyond the scheduled contract time.

Charles W. Parks, civil engineer in the navy, has been nominated by President Wilson to be chief of the bureau of yards and docks for a four-year term, with the rank of rear admiral. Mr. Parks will succeed Rear Admiral Frederick R. Harris, detached from that position to become general manager of the emergency fleet corporation, which position he now has resigned.

Waltham, Mass., on Dec. 18 held its first election since the adoption of the city manager plan. A council of 5 was elected. This council will appoint a city manager who will have charge of all the different departments of the city. George R. Beal is the mayor.

Progress in Reinforced Concrete Ship Building

The first self propelled concrete ship built on this side of the Atlantic was launched Nov. 14, at Montreal, Que. This vessel was constructed by the Atlas Construction Co., Ltd., Montreal, Que., of which Mr. Charles M. Morssen is president. This ship is single screw steamer. It has structural steel ribs and keel and a reinforced concrete hull. It is 126 ft. long between perpendiculars, 22½ ft. beam, with a depth of 12½ ft. The concrete shell varies in thickness from 3 in. to 5 in. between ribs which are 27 in. apart. The displacement is about 650 tons, and the carrying capacity will be about 300 tons. The boilers and engines are now being installed. This boat is intended for service on the lakes. The accompanying eight views show various stages of progress in the construction of this concrete ship.

A ship of about 5,000 tons carrying capacity is now being built at Redwood City, Cal., by the San Francisco Shipbuilding Co., under plans developed by Allan McDonald of McDonald & Kahn, San Francisco. This ship will be 320 ft. long, 44½ ft. beam and 30 ft. deep. At 24 ft. draft the displacement is said to be 8,000 tons. The weight of the hull is stated to be 2200 tons. Turbine engines of 2500 h.-p. equipped with reduction gears will furnish the motive power. In constructing this vessel the reinforcement was welded together, thus reducing to a minimum the quantity of steel required. This is the largest concrete ship now under construction. It is expected the work will be finished so that the launching can take place early in 1918.

In Norway two different companies are building ships of concrete. The Porsgrund Cement Casting Works, Porsgrund, Norway, launched a 200-ton motor lighter last August, and is reported to have under construction a ship of 1,000 tons cargo capacity. The design of the Porsgrund ship follows generally that of a framed steel ship. The general structure is a series of transverse ribs with a thin shell. The boats are built bottom up, an internal mold being used which is made in units that can be taken apart readily and reassembled. The vessel is launched in the same position in which it is built—bottom up—and by taking advantage through special arrangement of interior compartments, a small amount of water is admitted so that the vessel soon after being launched rights itself. Jens Hauland is vice president and general manager of the Porsgrund company. The other Norwegian company — the Fougner Steel Concrete Ship Building Co. of Christiania—has been building vessels since June, 1916. During this time the company has launched about 18 reinforced concrete ships and has several others under construction. The vessels now on the ways of this company include two 1600-ton capacity power driven seagoing vessels. It is expected these will be launched early in 1918. The company has also laid the keel for a 4000-ton ore carrying boat. This will be 254 ft. long, 40 ft. wide, and will have a 19½ ft. draft. It will be equipped with two 300 h.-p. Diesel engines. The 1600-ton boat is 172 ft. long, 31 ft. wide, and 18 ft. high, with a draft of 15½ ft.

The Fougner company launched its first seagoing concrete boat—the "Namsenfjord"—late last summer. This vessel made a round trip from Norway to England and is now in service in coast traffic in the first mentioned country. After extensive trials in rough

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A Concrete Ship in the Making

Views Showing Progress in Construction of the Concrete Ship Built by the Atlas Construction Co., Ltd., Montreal, Que.

Condition of the Work on Sept. 7, 1917.

Construction Progress to Sept. 14, 1917.

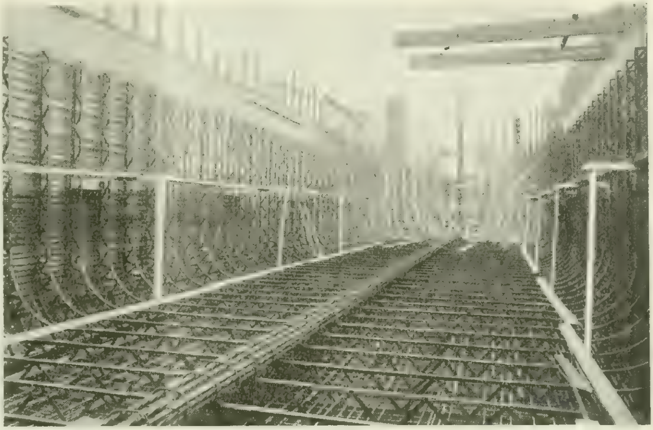
sea water the ship received a Class A-1 rating from Lloyds. This vessel is 84 ft. long, 20 ft. wide and 11½ ft. deep, with a draft of 9½ ft. The approximate displacement is 400 tons. The motive power is an 80 h.-p. Bolinder crude oil engine.

The "Namsenfjord" has a reinforced concrete keelson with cross frames of reinforced concrete every 4 ft. The skin is 3 in. thick, of concrete reinforced with wire mesh on expanded metal. Precast concrete plates spanning the top of the tops of the keel frames and jointed over them provide a double bottom. Watertight compartments are formed by concrete bulkheads, reinforced with metal lath. The engine bed is provided with a special reinforcing of longitudinal and cross beams. In the construction of the "Namenfjord" reinforcement was erected for the full height of the hull and the concrete poured in between the metal lath, which served as a form. The outside and inside of the lath was then plastered to give the full section.

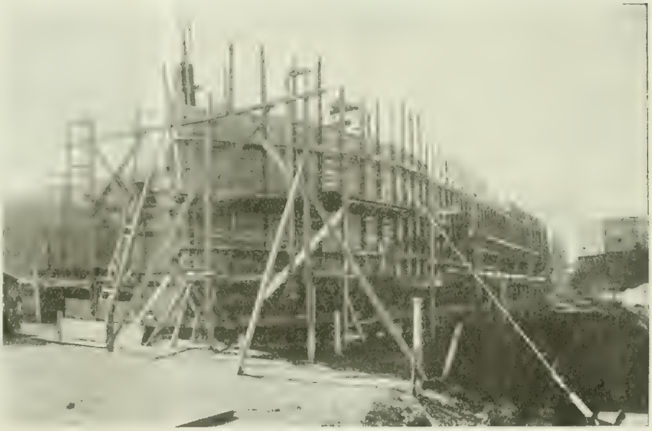
In England the firm of James Pollock & Sons Co., naval architects and engineers, London, is understood to be constructing several coasting vessels for its fleet of Miramac Motor coasters. The first vessel to be laid down is stated to have a length of 92 ft., a breadth of 19 ft. and a depth of 10 ft. It will be propelled by an internal combustion engine of the Bolinder type of 120 HP.

The development of self propelled concrete cargo-carrying ships has taken place in the last two years. Concrete barges, scows and pontoons, however, have been built for many years. In 1887 the Fabrieck van Cement Ijzer Weiken of Holland, constructed barges up to 11 tons capacity, which proved so successful that the plans were extended to cover the building of barges 64 ft. long, 14 ft. beam and 55 tons capacity. These boats had longitudinal and transverse bulkheads spaced approximately 6 ft. centers.

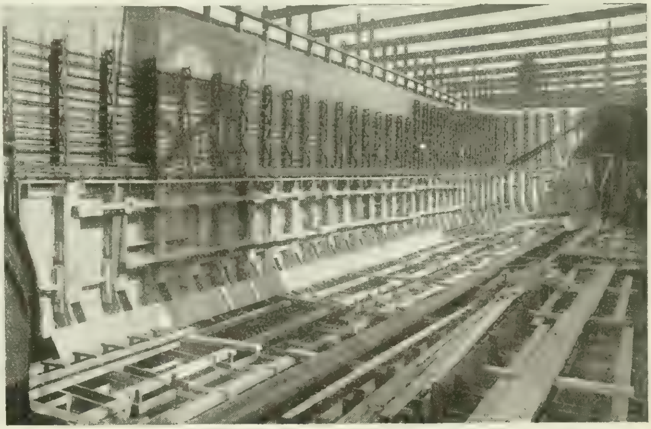
In 1899 Carlo Gabellini, of Rome, Italy, began the construction of concrete scows and barges. In 1905 he built a 150-ton barge for the city of Civita Vecchia and in the following year he constructed a barge for the military harbor at Spezzia for the use of the Italian Navy. The first step in laying down vessels under the Gabellini method, consists of placing the reinforcement for the keel



Reinforcing in Place Sept. 21, 1917.



Condition of the Ship on Sept. 28, 1917.



Construction View Taken on Oct. 10, 1917.

and ribs, usually consisting of round steel rods. This reinforcement is then covered on the outside with ¼-in. wire mesh, to which a 1-in. coat of cement mortar is applied by hand. A somewhat thinner coat of mortar is then placed on the inside, after which the ribs and keels are placed and concrete deposited for these parts of the vessel. Ribs run longitudinally and transversely and over them a ⅛-in. wire mesh is placed with a thin mortar covering plastered on. Finally a third and coarser wire mesh is pressed into the soft mortar and the entire surface trowelled over.

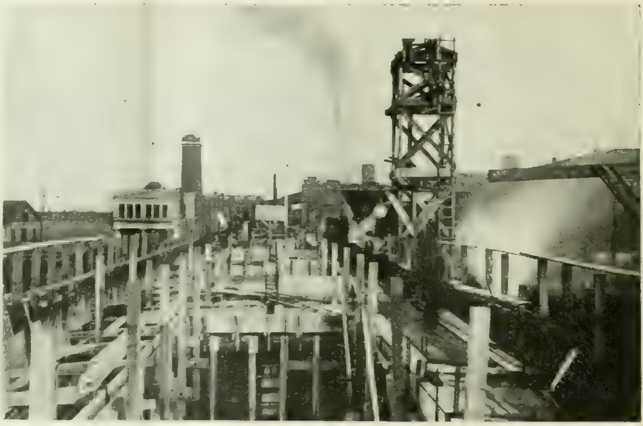
A concrete barge having a carrying capacity of 700 tons is now near completion at New York. This barge is being built by the Louis L. Brown Co., New York City. It will be 112 ft. long, 33 ft. beam and 10 ft. deep. The frame consists of reinforced concrete members in which deformed rods are used as reinforcement. The shell is reinforced with wire mesh. Concrete is to be waterproof in itself by proper proportioning, mixing and placing. The rail, bulkheads and deckhouse are also of concrete, the only wood used being that for the fender, wales and gunwales. This barge will have all the usual fittings common to floating structures of its kind and is intended for use in the harbors and inland waters.

The following summary, compiled by the Portland Cement Association, to whom we are indebted for the matter in this article, shows the principal designers or builders of concrete boats, barges and similar floating structures:

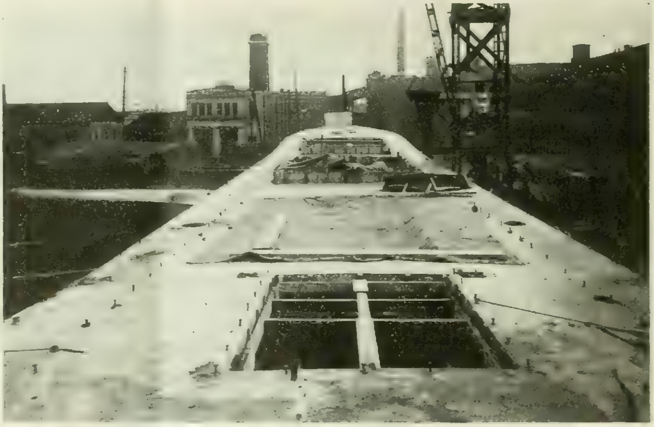
Concrete Ship Designers or Builders.

Name. Address

Booker & McKechnie—Davidson Building, Halifax, N. S.
E. W. Brown—Care of Elbert Clark Co., Engineers, Chamber of Commerce Bldg., Rochester, N. Y.
F. Huntington Clark—149 Broadway, New York.
Nicolai Fougner—Moss, Norway.
Jens Hauland—Porsgrund, Norway.
E. Lee Heidenreich—Dwight Building, Kansas City, Mo.
Allen Hoar—3231 Liberty Ave., Alameda, Cal.
Herbert Knight—Care of Grant Smith & Locher, 120 Broadway, New York, N. Y.
Oscar F. Lackey—Care of Louis L. Brown Co., 30 Church St., New York, N. Y.
David Pollock—Care of James Pollock, Sons & Co., Ltd., London, England.
Carl Weber—Care of Torcrete Shipbuilding Co., 910 South Michigan Ave., Chicago, Ill.
J. L. Weller—St. Catherines, Ontario.
James K. Sherman—2608 Campbell St., Kansas City, Mo.
John J. Smith—Old South Bldg., Boston, Mass.
Louis L. Brown Co., 30 Church St., New York, N. Y.
Atlas Construction Co., Ltd.—37 Belmont St., Montreal, Canada.



Construction Condition on Oct. 26, 1917.



Deck of Concrete Ship on Nov. 6, 1917.

Ship on Nov. 6, Eight Days Before It Was Launched.

Fire Proof Building Construction by Cement Gun Process

One of the latest developments in the building field is the employment of the cement gun process not only for the construction of the roofs and side walls for factories and warehouses, but also for encasing the timber members of the structures. Several projects of this kind have been carried out during the present year by the Cement Gun Construction Co. of Chicago.

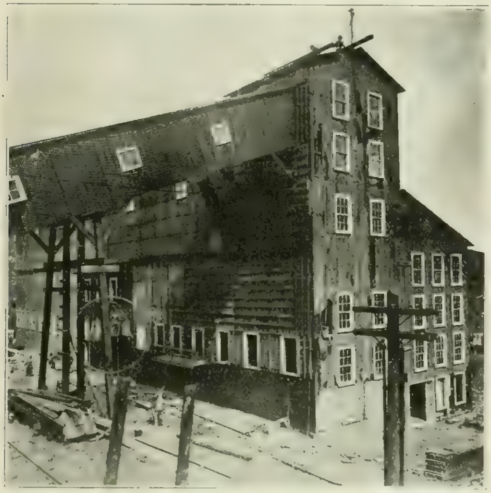


Fig. 1—Partially Gun-Creted Concentrating Mill Building. Completed wall is shown at left hand end of building. Nozzle operator applying coating is shown in the circle.

One of these undertakings called for the construction of gun-crete walls for a building at Victor, Colo. This building was put up in the fall of 1916 of mill frame construction. It is used as a concentrating mill building and is filled with heavy machinery. It was necessary to enclose the building at once so that the installation of machinery might proceed; so 1-in. boards were nailed between the main building posts and girts close together and a light tar paper tacked all over the outside, thus keeping out the weather to a sufficient extent to permit placing of machinery inside.

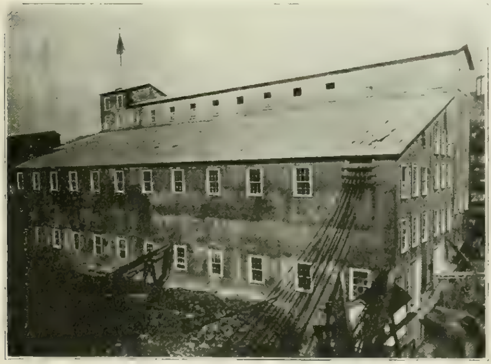


Fig. 2—Finished Concentrating Mill Building at Victor, Colo.

As soon as weather permitted in the spring of 1917, the Cement Gun Construction Co. removed the tar paper, took out the light 1-in. boards, which were no longer necessary, stretched a wire mesh from timber to timber and built up a 2-in. gun-crete wall all over the structure. The first operation in the process was to place the wire. This was thoroughly stapled to the frame work and wired together, overlapping both sides and ends of the sheets, making a thoroughly good reinforcement of sufficient strength to give the desired strength to the wall and to resist temperature stresses. Light wooden panel forms were then placed against the wire netting on the outside. In the illustration (Fig. 1) these forms are shown in position at the right-hand end of the large side wall. One-half the thickness of the gun-crete coating was then shot through the wire against these forms from the inside, leaving the appearance of the wall, when the forms were removed, like that shown immediately to

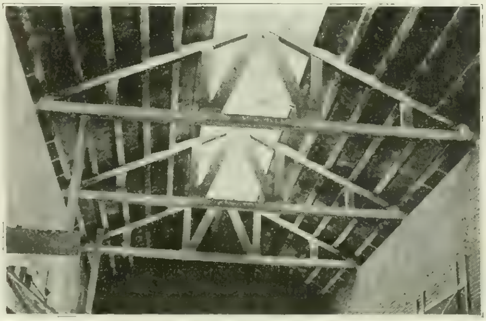


Fig. 3—Wood Trusses, Purlin and Roof Slab of This Building Are Encased in Gun-crete.

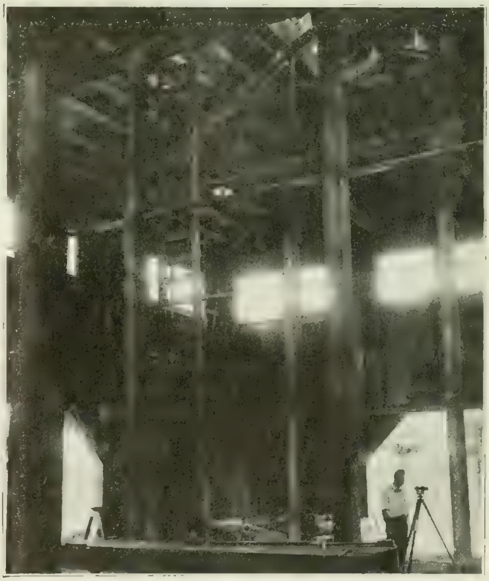


Fig. 4—Interior View of Oil Refining Building Showing Gun-Crete Encasement of Roof Trusses, Purlins and Monitor Frame.

the right of the men on scaffold, near the center of the picture. After removing the forms, the remainder of the thickness of the wall was shot from the outside. Figure 1 shows the nozzle operator applying this outside coating, while at the left-hand end of the building the completed wall is shown. In this way a 2-in. gun-crete wall thoroughly reinforced was built up half from the outside and half from the inside, making a thoroughly homogeneous wall of great strength. A view of the finished building is shown in Fig. 2. This process of building gun-crete walls is thoroughly protected by patents.

A similar piece of work was carried out at Tupper Lake, N. Y., for a large wood working plant. One of these buildings was 400 ft. long by 360 ft. wide.

For oil refinery buildings near Houston, Tex., gun-crete was used both for the walls and roof and for encasing all the wood frame work inside. In this work wooden frames were erected and the gun-crete walls and roof were shot in place by a method similar to that described above.

An interior view of one of 16 wood frame buildings that were gun-creted is shown in Fig. 3. It will be noticed that the roof trusses, which were made of wood, are encased with gun-crete. The purlins are encased and the roof slab is a gun-crete slab. All posts were also encased so that there is no exposed wood work anywhere about the building.

The timber frame work, consisting of columns, girts, trusses, etc., were first covered with tar paper. The purpose of this was to keep the cement away from the wood, as wood is about the only material to which gun-crete would not adhere. The wood is absorbing moisture and separating, while the gun-crete is giving up its moisture and contracting, and so when gun-crete is applied direct to wood, cracks are bound to occur. For this reason, tar paper is first applied. Outside of this there was applied a very light herring-bone lath and then 1¼-in of gun-crete was shot in position.

An inspection of this timber frame work made recently, after the work had been done about six months, showed no corner cracks whatever. There were only a few very fine hair cracks, running around at right angles to the timber, such as may be expected in all concrete work.

Some of the buildings at this oil refinery for certain reasons had to be built of brick work. Figure 4 shows an interior of one of the structures. It will be noticed that all the timbers constituting the roof trusses, purlins and monitor frame are encased with gun-crete.

Citizens of Fukuoka, Kiushu, have undertaken a plan for the establishment of a company with $7,228,250 capital for the purpose of making a railway tunnel under the Mogi Straits. The tunnel will start at Shimonoseki and end at Dairi, Fukuoka Prefecture, and it will be connected with the railway trunk line of Kiushu. The total length is put at 17,700 ft., of which 4,000 ft. will be beneath the sea.

The Public Buildings Committee in its first report recommends that Congress appropriate $58,000,000 for land and buildings for housing all the government's activities in Washington. At present the government is paying about $1,059,000 a year in rents for private buildings in Washington.

The Kansas Engineering Society will hold its 11th annual meeting at Lawrence, Kan., on Jan. 15 and 16.

Some Reflections on the Architecture of Bridges

Translated and Adapted from Séjourné's "Grandes Voutes," by D. B. Steinman, C. E., Ph. D.

Associate Engineer, Waddell & Son, Consulting Engineers, New York.

Introduction—In M. Paul Sejourne's recently published monumental work on Great Arches ("Grandes Voutes"), there abound sections and passages of rare value of content and beauty of expression which are in danger of being lost to many engineers on account of the barrier of language or of price. In order to bring some of this material—the recorded thought and experience of a master in his specialty—within the more general reach of American designers, the writer has undertaken its translation and has secured the generous consent of M. Sejourne to its publication.

Accordingly the following translation of passages from a chapter on the artistic design of bridges is presented to the readers of Engineering and Contracting and is commended to their attention as an unusually striking and authoritative contribution to the literature of bridge architecture.

Although the remarks were intended to apply primarily to masonry and concrete arches, there will be found many thoughts expressed which are equally pertinent in the artistic conception and design of other engineering works.

The Essence of Bridge Architecture.—A bridge is built to carry traffic; it is fundamentally a work of utility, and should therefore possess strength and durability. This should be expressed in the architecture. In appearance, as well as in fact, a bridge should be suited to its purpose, substantial, clear, simple, well executed, without vain ornamentation.

In the words of Perronet (1777): "Great bridges being monuments which serve to make known the grandeur and genius of a nation, we cannot pay too much attention to means for perfecting their architecture; this may be varied in treatment, but there must ever be conserved, in form and in decoration, the indispensable character of solidity."

Referring to the bridge de la Concorde, the same authority wrote (1782): "Before building this bridge in the capital, at a site which nature and art had endowed with the finest scenery and the most magnificent edifice, we considered it indispensable to give the bridge, a decorative character. We have not, however, employed sculptural ornamentation of any sort, as we wished to avoid departing from the quality of simplicity, sacred to monuments of this class, as well as to avoid weakening the virile character which is so essential in bridge architecture."

Proportions.—The architectural value of an arch bridge depends upon its general form, its principal lines, its proportions, the curve of its intrados, and upon a happy ratio of span to height and of rise to span; decoration scarcely counts in this regard.

Each element—arches, piers, abutments, spandrel walls, coping—should have its due share of importance; it should not dominate over the other elements and should be well adjusted to the ensemble.

All parts should be light in a bridge that is light; and all massive in a bridge that is massive.

Light arches should not be weighted down with a heavy spandrel, slender piers with imposing belt courses, nor open spandrels with a solid parapet.

Fitness to the Location.—A bridge should appear adapted not only to the site, but also to the climate, to other monuments in the vicinity, to the light, and to the local color scheme. It should partake of the character of the ground, since it naturally springs from the soil; and it must not produce the impression of being imported, transplanted: if in Toulouse, it should be a Toulousian bridge.

Viaducts.—The beauty of a viaduct is found in its ratio of span to height, in its ascending ground slopes, and in the curve of its intrados. Nothing should be permitted to cut across the piers; no pedestals, no belt-courses at the springings, no capitals on the pilasters, no steps at the footings, no projecting courses—no horizontal lines whatever except those of the coping.

The Calculations Should Not Dominate the Design.—After the design is made, not before, its safety should be determined; science should aid art, but should not smother it. If there is a deficiency of material at any point, it should be added, but without offending the eye; in such case, it is not necessary to show all the material needed for structural security; thus, we may conceal behind a solid spandrel wall an arch which is too thick at the haunches. If there is an excess of material it may be cut down, but only as the eye may permit.

Imitating Other Designs.—In imitating, do not copy the defects. When limited to copying, one should at least aim to harmonize what is borrowed; for example, the elements of a massive bridge should not be grafted on to those of a light structure.

There has been too much copying during the past hundred years or more.

Importance of Esthetics.—In all engineering works, even the minor ones, the appearance must be considered; it is not permissible to create ugliness.

There prevails a peculiar notion that whatever is fine is necessarily expensive, and whatever is ugly must be economical. There are structures ugly and dear, beautiful and cheap.

It is only in the general layout that economy can be secured; after that, one can only scrape and skimp. What is saved is petty, and it appears poor taste to spoil a structure for such trifling saving in the total cost.

Always Strive for Improvement in the Art of Bridge Design.—Although the art of bridge building has been practiced for over 2,000 years, everything has not been done; there is ever room for improvement. In a great city, in a capital, we have no right to put up a large bridge that does not mark progress in the art.

As aptly expressed in a memorial presented to the king by the States of Languedoc in 1779: "It may perhaps result in an increased expenditure; but in the art of bridge building we must ever strive for perfection, and the ideal can be approached only through great examples. It may cost more for the particular bridge we are undertaking, but it will cost less for those that follow."

We now have excellent mortars; the problems of difficult foundations have been solved. With all improved facilities, shall we turn out work inferior to that of the ancients?

Engineers Should Know Architecture.—The savants who founded the Ecole Polytechnique: Laplace, Monge—established there a course in architecture. At the Ecole des Ponts et Chaussees, it is also taught—and very well.

There is no denying that engineers should have a good knowledge of the resistance of materials; but the useful is not all. Intellectual training should not be restricted to the utilitarian, and it has been a crime to sacrifice to the latter—only temporarily, let us hope—the old Humanities.

General Treatment of Arches.—The thickness of the courses, the vigor of treatment, the massiveness of design, and the apparent weight of the materials should progressively diminish from the ground toward the coping.

The piers and abutments, being the supports of the structure, should be particularly massive. In order to convince the eye they are provided with heavy courses, with mouldings; they are given a batter.

The Arch Ring.—In a masonry bridge, the arch ring is everything. The heads of the arch are accentuated by a pronounced projection from the spandrel walls and by the voussoir treatment. For relief they are set off by archivolt.

We exaggerate the dimensions of the keystone; it is made to project above and below the ring course; it is flanked by two counterkeys; on it we sculpture a cartouche or modillion.

Spandrel Walls.—The spandrel walls, which are borne on the back of the arch, should be and should appear light; they should be built of thin courses or of brick. It should be avoided, even in a metropolitan location, to make them of stones of massive height. We pass relieving arches through them. In a long bridge, we break them up with the lines of shadow cast by pilasters.

Pilasters.—On a pier a pilaster serves to separate and frame the adjoining arches; on a pier-abutment it is effective in separating the large arch from the small approach arches.

Laid on as veneer upon a solid abutment, a pilaster merely forms part of the abutment and does not serve to separate anything.

We treat pilasters with more vigor of style than the spandrel walls which they frame, but with less vigor than the piers which they surmount.

The Coping.—To properly view a bridge, it is necessary to stand off at a sufficient distance; then one no longer sees the small mouldings of the copings, cornices, bases. It is therefore important to make the mouldings few in number, but simple, clearly visible at a distance, with strong projections.

The height and projection of the cornices should be adjusted to the bridge.

Upon a heavy bridge we place solid spandrels and a thick cornice; upon a light, open bridge, an openwork parapet; above the piers, which should always appear robust, a solid parapet.

Respect for Old Bridges.—Old bridges have often been spoiled in efforts to enlarge them.

In the case of the Tournelle bridge at Paris and of the Guillotiere bridge at Lyons, no very great damage has been done.

But it was a mistake to touch the beautiful bridge of Entraygues (over the Truyere, 13th century).

We have met engineers who proposed to demolish the beautiful bridge of Toulouse (1542-1632), the only bridge in the country to survive the terrible flood of 1875.

It is wicked to destroy an achievement, an ornament of the fatherland: we thereby impoverish ourselves.

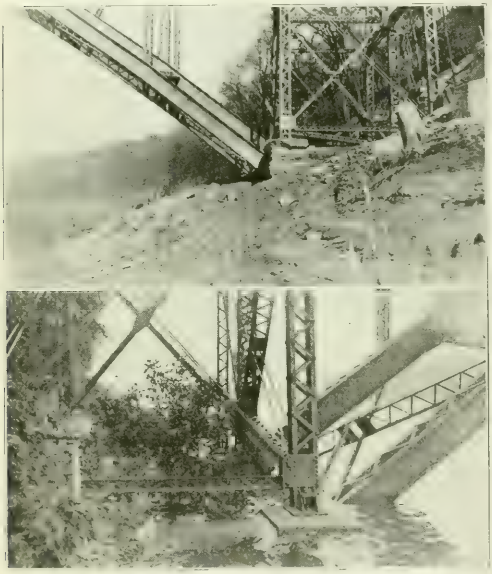
Those works which have endured we should respect above our own.

Let us remain faithful to the past, upholding the present and making sure of the future; and let us guard from the barbarians our old bridges, our old churches, our old France—Praeteriti fides, spes futuri.

Methods of Protecting Steel Work of Marshall Ave. Bridge, St. Paul, from High Water

The recently completed Government dam and locks built for the improvement of the navigation of the Mississippi River between St. Paul and Minneapolis, caused the water level to raise about 30 ft. at the dam, the raised water level extending up to the St. Anthony Falls, Minneapolis, a distance of about 6 miles.

The river, for part of this distance, forms the boundary between the two cities, and several bridges, highway as well as railway, connect the two banks of the river. All these structures, however, with the exception of the Marshall Ave.-Lake St. bridge at St. Paul, are deck truss bridges, supported on high masonry piers, and the raise of the river was of no serious consequence except in this particular case.



Top View: East Pier at Low Water; Looking Upstream. Lower View: Water Raised to Low Water Stage; Looking Downstream.

The Marshall Ave. bridge consists of two three-hinged steel arch spans of 456-ft. span each with a short steel trestle approach at either end. The main piers, one at the foot of each bank, and one in the middle of the river, are solid masonry piers supporting the three arch ribs of the spans.

Before the dam was completed, the piers, as well as the steel shoes supporting the ribs, were well out of the reach of the highest water stage of the river. After the raise of the water, the low water stage will be approximately level with the tops of the piers, and the high water will go about 7 ft. higher, leaving part of the arches below water level at all times. It may be noted that the center arch rib, built about 10 years ago for the purpose of reinforcing and widening the bridge, the shoes of same being placed a little higher than the outer arch rib, will not be covered so deeply as the old part of the structure.

It was found necessary, of course, to protect the steel, not only against corrosion, but also against ice and timber drifts. The ice at this place probably will be from 2 to 3 ft. in thickness. The method of protection selected takes into consideration that sometimes during the year, and more especially during the winter season, the low water stage will exist, at which time it will be possible to reach the portions of the steel only covered by the high water, inspect it, and if necessary clean and paint the corroded parts. The part of the chords and shoes, however, permanently buried below low water, had to be treated otherwise. Furthermore, the arches are three hinged and the question of allowing for a slight movement at the pins also entered into this consideration, making it unsatisfactory to cover the arches with concrete.

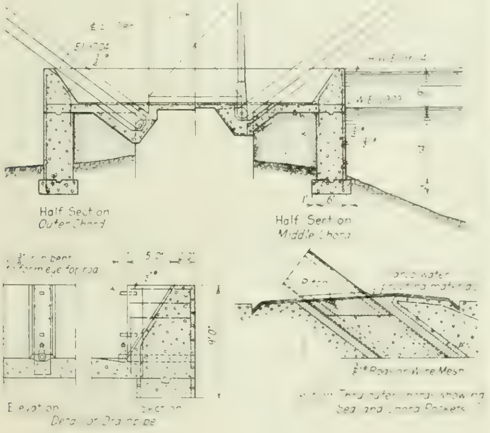
It was therefore decided to treat the lower portion in the following manner: First clean the steel as well as possible from dirt, rust, loose paint, etc., by means of sand blast and blow torch, then give the steel a first coat of Sarco metal primer and as a second coat use Sarco mineral pipe coating, applied hot. This same protection is to be given to the steel up to an elevation of about 4 ft. higher than expected high water. A concrete slab will then be placed on top of the pier, the top of the slab being about 6 in. above low water, leaving pockets as small as practicable around the arch ribs and connecting laterals—these pockets are to be afterwards filled with Sarco bituminous putty, or a putty of such consistency that it can be poured in hot and that will stay soft or pliable at low temperatures. In order to reduce the amount of putty, concrete will be placed inside and around the shoes and also inside the arch rib itself, leaving a sufficient space for putty around the pins and for a seal at the top of the concrete slab. Partly for the support of this slab, but mainly for the protection against ice and drifts, a concrete retaining

Top View: Middle Pier with Water at Its Original Level. Lower View: Low Water Stage During Summer of 1917.

wall will be built around the pier. The top of this wall will be 1 ft. higher than high water. The concrete slab over the pier will then, together with the upper portion of the retaining walls, form a basin with the lower parts of the arch ribs and tower posts inside of same. The top of the floor slab will be finished off so as to drain away from all steel surfaces and given a slope towards a valve outlet put in through the retaining wall.

The intention is to let the water rise inside the basin to the same elevation as the river outside, depending on the protection of the steel by paint. If, however, this should be found unsatisfactory, the inside of the retaining walls and the top of the slab may be thoroughly waterproofed and the gate valve kept closed, thereby exposing the steel only to water that may collect from rain or snow. This waterproofing may be undertaken at any time after the structure is finished.

Plans have been prepared for the east shore pier and for the center pier, the west shore pier being on the Minneapolis side. The contract has been let for the work on the east side and construction started.



Details of Steel Protection Work at Center Pier.

The work at the center pier has been temporarily delayed, awaiting final approval and action from the Engineering Department of the City of Minneapolis, which city will share with the City of St. Paul the cost of protection of this middle pier.

The plans and specifications were prepared by M. S. Grytbak, Engineer Bureau of Bridges of St. Paul, under the supervision of Mr. O. Claussen, Chief Engineer, and Mr. M. N. Goss, Commissioner of Public Works.

Contract has been let to Thornton Bros. Co., St. Paul, for the construction of the east pier protection at a cost of $9,873.

To keep more directly in touch with the interests of shipping in the waters of Maine, New Hampshire and Massachusetts, the United States Coast and Geodetic Survey, Department of Commerce, will establish a sub-office in the custom house at Boston about Jan. 1, 1918. As inspector in charge of this office, Homer P. Ritter, a commissioned officer of the Survey, will be prepared to furnish information relative to the operations of this branch of the government service.

"Elements of Structural Design" and "Design of Simple Structures"*

Reviewed by J. A. L. WADDELL.

Consulting Engineer.

These books are the first two volumes of a 3-volume treatise of which the titles are respectively "Elements of Structural Design," "Design of Simple Structures," and "Design of Advanced Structures." The last mentioned is still in course of preparation. It will deal mainly with movable bridges, suspension bridges, cantilevers, and arches.

Professor Thayer in the Preface of Vol. I, states as follows: "The experience of the author in teaching and in practice has led him to believe that no available book presents all structural subjects so concisely that they can be covered in the time usually allotted by technical schools. Moreover, the fundamental principles of shop practice and erection, which govern the designer at every step, are not clearly developed. These faults the author has attempted to correct, using only orthodox methods of presentation."

In covering so wide a field, the author has necessarily touched many subjects rather briefly. Throughout he, very properly, "presupposes a knowledge of mechanics, stresses, and the mathematics on which they depend."

In Vol. I, Chapter I treats briefly of "Materials"; Chapter II discusses "Commercial Shapes" in both wood and metal; Chapter III outlines the designing of common types of wooden structures; Chapter IV is entitled "Fabrication of Structural Steel," and deals with the organization and layout of fabricating works, machines, and tools with their uses, fabrication processes, and erection methods; Chapter V, covering "The Engineering Department," treats briefly of specifications, economic considerations in the layouts of structures, estimating, designing of various members, detailing, preparation of drawings and bill sheets, checking, examinations of existing structures, and failures.

Vol. II takes up in considerable detail the designing of the following types of structures: Beam bridges and plate girders, both railway and highway, with their floors; steel viaducts and elevated railroads; simple riveted-truss bridges, including a brief treatment of secondary stresses; simple pin-connected bridges; steel mill buildings, taking up not only the framework, but also outside coverings, roofings, floorings, windows, etc.; high office buildings, discussing briefly general features, costs, foundations, structural frameworks, floors, cornices, protection of steel, etc.; miscellaneous building work; and standpipes and elevated tanks.

The two volumes, as will be seen from the foregoing lists, cover the field of designing ordinary structures in a somewhat general way. They go into detail sufficiently in most points for students, although hardly far enough for practicing engineers. Designing and detailing are treated almost entirely from the standpoint of the bridge shops. One might suppose, from reading these books, that most structural engineering is handled entirely by the shops, although, in fact, the more important design work is done by consulting engineers and railway bridge engineers.

As text books these two volumes will serve an excellent purpose; and it is probable that there will be a large demand for them from the technical schools of the United States and Canada. In preparing them the author has done a most praiseworthy piece of work for the engineering profession; and it is to be hoped that his third and final volume will keep up the high standard set by its predecessors.

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*By Professor Horace R. Thayer of the Carnegie Institute of Technology.

Awakening Recognition of the Engineer*

It would appear that the awakening of the engineering profession involves, in the first instance the increased recognition of the profession's responsibility to the individual, and the individual's responsibility to the profession, and in the second place their collective responsibility to the public, and in turn an acknowledgment from the public of the engineer's real place in national affairs, which includes status, remuneration and opportunity of service.

You will find, generally speaking, that the recognition engineers have received has been as individuals rather than as a profession. Fifty years ago the engineer was a skilled laborer, and his status was such. During that time he has become a man, highly educated, highly trained, and so successful in his application of knowledge to material things, that his work has wrought untold benefit to humanity. The great achievement of the engineer in revolutionizing the material welfare of mankind has fitted him to shoulder greater burdens and responsibilities.

The gradual evolution of the status of the engineer has forced him to take account of other laws and forces than those of mathematics and science, so that today he is compelled (almost without realizing it) to consider economic and social problems, and particularly those arising out of a proper appraisal of equity between man and man. The latter includes a study of the complex problems of tax valuations as between individuals and corporations, advice as to financing of public works, and advice in arriving at just and equitable rates for service rendered by public utilities. The engineer is thus becoming not only one who directs the great sources of power in nature for the use and convenience of man in the most economical manner possible, but he is fast becoming an economist and an arbiter in industrial problems.

When a committee was appointed in 1915 by the President of the United States from the National Engineering Societies to constitute a Naval Consulting Board and Committee of Industrial Preparedness, the profession received its highest recognition. This, in fact, is an epoch in the relation of engineers to national affairs. Of this action on the part of the President, Thomas A. Edison said, "This marks almost dramatically the entrance of the trained non-partisan, doing his work on the sole basis of efficiency and integrity, into the affairs of the government." The men who are thus chosen have an opportunity of not only making a name for themselves, but of adding much to the prestige of the profession, and there is no doubt whatever that they will do so.

The government of the United States appointed as Food Controller, Herbert Hoover, M. Am. Soc. C. E. Canada appointed a lawyer for this office. Note the difference. The engineer went about his work with the idea foremost in his mind of carrying out and securing the desired result for which a Food Controller was needed, namely, to conserve food resources, assure reasonable prices, eliminate profiteering and assist the Allies to secure supplies. The work of the engineer Food Controller in the United States has resulted in the prices of food products steadily decreasing, while in Canada during the same period, they have increased by leaps and bounds.

Here we have a practical, definite illustration of the difference of what is to be expected from the appointment of an engineer when something definite was to be done, in contrast to a lawyer. This is possibly the first time we have had an opportunity of comparing the methods of the two, and we owe it to ourselves to educate the public to this fundamental difference of attitude of mind and directness of purpose between the methods of the engineer and the politician. The significance of this example cannot be too strongly emphasized and cannot be too firmly impressed upon the minds of the citizens of this country.

If the striking manner in which engineers carry out special work assigned to them is not sufficient to give the whole profession added prestige, then the part played by our gallant men in connection with the great war should surely have some effect. We have nearly 30 per cent of our entire membership actively participating in the war. They have performed deeds of bravery and endurance that would put to shame the heroes of history or mythology. They have made it possible to conduct the great campaigns by providing transportation, water and sanitary facilities, while exposed, for the most part, to the fire of the enemy, and the war will be won largely by the superior engineering skill of the Allies in comparison with the Germans, whose whole history has been one of stolen ideas.

To accomplish any near approach to our possibilities greater unity and co-operation will be necessary. These to some extent might become our watchwords.

Events in the world of engineering activities show clearly and unmistakably that a new era is dawning for the profession. The insularity of the engineer is slowly but surely giving way to a fraternity of spirit that has been almost entirely lacking in the past. The former idea of specializing in various groups has been transformed to a broader vision with a tendency towards union of all branches of the profession.

You have seen recently for the first time in the history of the profession a national engineering board appointed by the United States from the parent engineering societies, whose whole tendency seems to be towards closer union and greater co-operation. To some extent we are in a more advantageous position in Canada, as we have now made it possible to unite all the engineering professions in one great national body instead of starting a number of organizations as was done in the United States. It will mean that the members of our organizations will have to work as a unit and co-operate in the closest possible manner. The situation affords a great opportunity to the engineering profession, an opportunity in which every individual may take an active part, a chance to advance the interests of the profession in one great body of such strength of sufficiently high standard and at the same time broad enough to make it the goal of every man in this country who aims or claims to be a member of this high calling.

We have been criticized in the past, not only because we were accused of being narrow in our objects, but also it was stated we were collectively without a soul or heart. Be that as it may, if the heart of the profession were a composite heart of the individuals therein it would leave nothing to be desired, but we must admit there has been some coldness and to some extent indifference, and we should therefore to the greatest possible extent cultivate a fraternal spirit that will develop a heart in our organization, a pulsating, personal heart throbbing with human emotions, and cause that heart to beat warmly and sympathetically not only for our own members, but in our relations with the outside world.

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*From an address by Fraser S. Keith, general secretary Canadian Society of Civil Engineers, delivered before the Ottawa Branch of the Society.

Two definite factors in increased earning capacity are—additional usefulness and added recognition. The usefulness must come from within, and we may take it as an established fact that the engineer has already proven his usefulness over and beyond his monetary reward. Recognition will come from corporate usefulness and educating the public to a better appreciation of what the engineer is really doing. One of the technical journals in discussing the question as to when engineers will be better paid, says, "The inevitable conclusion of any careful study of this question is that engineers will continue to draw low salaries as long as they will work for them. Meanwhile discussion of the question is not wholly without value as men can talk themselves up to the point of making even a bayonet charge. Perhaps after some more years of discussion engineers will begin to ask themselves: 'What are we going to do about it?' After some more discussion somebody will suggest that engineers must demand better pay. Again, after still further discussion, the suggestion will be adopted. Then, and not until then, will the engineer become a permanently well-paid professional man."

Let me ask you, what position would the Government of Canada be in today in carrying out the nation's work without the services of the men in the engineering profession? The majority of the departments of the government would be unable to operate without our help. Do the political members of the Government realize that this is true? It is certain that they do not. Why? Because we of the engineering profession have in the past taken no corporate action to insure that they should. Instead we have to some extent acted like dumb driven creatures, accepting the crumbs that have fallen by the wayside, content to sell superior qualities of mind and training for a mess of pottage; for despite your capacity, such in general is your reward in comparison with your true worth. As individuals it may not be possible to force the recognition needed, but as a body we are a mighty power capable of securing any reward within reason upon which we set our minds and hearts. It is not only in the government service that engineers receive inadequate reward, but throughout the entire profession, and particularly those employed at railway work.

There is one active full member of our Society who is a resident engineer on one of the transcontinental railways, and his salary is $100 a month. He has a wife and family. Whose fault is it that such is true? Yours and mine. How much longer is the engineering profession going to continue to be underpaid? Just as long as we permit it, and no longer. We have it in our hands to bring about a different state of affairs, but action is required, not words. We have talked in the past a great deal about inadequate rewards, and we may continue to talk, but nothing will be accomplished until we secure a higher standard of reward, and we shall find the accomplishment so easy that the wonder will be why we had not thought of doing so sooner. We are today exactly in the position of the man staying out all night on his own doorstep because he thought he could not get in, only to find out in the morning that he had the key in his pocket.

The government and railway officials and the general public have only a vague conception of what they owe to the engineering profession for their material welfare, and they will continue in ignorance until we have educated them. In the meantime it is we who are culpable, not they.

The newspapers in this country are the great moulders of public opinion, and it is to them we must look, to some extent at least, for co-operation and assistance. For once we have convinced the editors that in doing this they are assisting in the public weal, the natural patriotism that characterizes the editorial body would prompt them to act and give their hearty support.

To those of you who have become discouraged over the outlook of the engineering profession, let me carry a note of optimism, for the star of the engineering profession has risen above the horizon; it is well started on its upward path of glory and eminence, and just as surely as the past century was an era of material development unprecedented in history, credit for which is largely due to the engineering profession, just so surely will the coming century see a similar social improvement, whereby the social conditions of the great mass of mankind will be improved, and to a similar extent as were material conditions during the past century, and the group of men who wrought the former change will also be responsible for the greater change that is to come.

The lawyer and the politician have admittedly failed to solve the industrial relations of man to man and the relations between capital and labor. The very qualifications of mind and training that have enabled the engineer to so successfully grasp and solve any problem set before him will be called upon and required to solve and to deal with what will be after the war, the greatest problem which we have to face.

We find already many of the executives of large industrial concerns being chosen from our own profession and more and more will the men who have received a thorough training in technical matters be called to the high positions in industrial affairs. This will mean the opening up of a scope for the profession, giving rise to a future that will place the technical man in control of the industrial life of the nation. Coincident with that is arriving a condition whereby the engineer must, besides drawing plans and specifications, give his advice in connection with financing of any industrial or engineering undertaking, so that the time is coming, and very soon, that the engineer instead of receiving the reward that capital is willing to offer, will walk hand in hand with the capitalist, on an equal footing, and will share in the rewards that the other has heretofore enjoyed.

In view of such enticing prospects and possibilities for the individual, what limit is there to our development as a profession by acting in unison? Here we are, a powerful legion with all the potential attributes of mind, heart and soul to carry us to undreamed of heights of eminence, and how far we shall rise as a profession is only limited by the minimum amount of effort which each and every one of us is prepared to give in connection with his fellows to make what is reasonably possible a living reality.

The records of the Bridge Builders' & Structural Society, as collected by its Secretary, show that during the month of November, 1917, 77 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Tests of Oxyacetylene Welded Joints in Steel Plates

A series of tests of the strength of oxyacetylene welded joints in mild steel plates has been made recently in the laboratory of applied mechanics of the University of Illinois. The results of the tests are set forth in Bulletin No. 98 of the Engineering Experiment Station.

The plates were furnished by the Oxweld Acetylene Co. and the welding was done by the company at its Chicago plant. Tests were made under three conditions: static load in tension (in a testing machine), repeated load (bending), and impact in tension (in a drop testing machine).

The plates in which the test joints were made were of steel with a carbon content of about 0.16 per cent. The following thickness of plate were used: No. 10 gage, ¼ in., ½ in. ¾ in., and 1 in. In all, 11 plates were furnished, three ½-in. plates, and two each of No. 10 gage, ¼- in., ¾-in. and 1 in.

The approximate speeds of welding for the various thicknesses of plate were as follows: No. 10 gage, 0.51 in. per minute; ¼-in. plate, 0.29 in. per minute; ½-in. plate, 0.22 in. per minute; ¾-in. plate, 0.13 in. per minute; 1-in. plate, 0.11 in. per minute.

The tension tests for static strength were made in a 100,000 lb. Riehle testing machine fitted with an autographic apparatus for drawing load stretch diagrams. The repeated stress tests were made in an Upton-Lewis endurance testing machine. A Hatt-Turner drop testing machine was used for the impact tests. Nearly all tests were run in triplicate. There were 104 tension test specimens, 100 repeated stress specimens and 58 impact specimens tested.

The prime object of the tests was to furnish a comparison of the strength of oxyacetylene welds in mild steel plates with the strength of the original plate. This ratio of strength will be called the efficiency of a joint. The efficiency of a joint may be computed by either of two methods: The strength of a test piece containing a welded joint is compared with the strength of a test piece of equal width cut from the original plate, with no allowance made for the additional thickness of the welded test piece due to the addition of filler material; or the intensity of stress at yield point or rupture for joints and for plate material may be computed from the load and the dimensions of the cross section. The efficiency given by the first method will be called the joint efficiency and the efficiency given by the second method will be called the efficiency of the material in the joint. In general, joint efficiency is of more direct practical interest than is the efficiency of the material in the joint.

The test results are summarized as follows in the bulletin:

These tests were made on joints welded by skilled workmen in a shop especially fitted for oxyacetylene welding. They should not be considered as indicative of the strength of welds made in repair shops, or of welds made by workmen without special training in the use of the oxaycetylene torch.

For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent for plates ½ in. thickness or less, and to decrease for thicker plates.

For static tension tests the efficiency of the material in the joints welded with no subsequent treatment is not greater than 75 per cent.[*] The joints were strengthened by working the metal after welding and were weakened by annealing at 800° C.

The results of the repeated stress tests give an index of the endurance qualities of the joints, and they follow in a general way the results of the static tests.

For repeated stress tests the joint efficiency seems to be about 100 per cent for plates ½ in. or less in thickness, while the efficiency of the material in the joint is somewhat less. Hammering or drawing the weld while hot increases the strength, and annealing from 800° C. lowers it.

For static tests and for repeated stress tests, the joint efficiency sometimes reaches 100 per cent; the efficiency of the material in the joint is always less. This indicates the necessity of building up the weld to a thickness greater than that of the plate.

The impact tests show that oxyacetylene welded joints are decidedly weaker under shock than is the original material; for joints welded with no subsequent treatment, the strength under impact seems to be about half that of the material.

If the welded joint is worked while hot the impact-resisting qualities are slightly improved, though this does not make the joint equal to the original material in impact-resisting qualities. Annealing from 800° C. seems to have very little effect on the impact-resisting qualities.

In general, the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxyacetylene welded joints in mild steel plates.

Personals

F. E. Kurzenknabe has been appointed engineer and manager of the Fayette County Road Department at a salary of $3,000 per year. Mr. Kurzenknabe came to Lexington, Ky., the county seat of Fayette, some 4 or 5 years ago in the interest of the Louisville & Nashville Ry. Co. as engineer and supervisor of its Lexington yards and the building of the Jefferson street and West Main street viaducts.

Commissions in the Engineers' Reserve Corps as follows were announced last week by the War Department: Major, Engineers—C. D. Barrett, Fort Wayne, Ind. Captain, Engineers—F. T. Bowles, Kankakee, Ill.; H. A. Terry, St. Paul, Minn.; M. V. Terry, Flint, Mich.; G. E. Sutton, Brown Valley, Minn.; H. A. Feldes, Gibson, Ind.; H. P. Wilson, Detroit, Mich.; B. W. Bodell, Monroe, Mich.; L. A. Barton, Deerwood, Minn.; E. L. Behren, Muskegon, Mich.; F. N. Johnson, Superior, Wis.; L. Fitz Gerald, Gary, Ind.; J. E. Finley, Minneapolis, Minn.; H. K. Davis, Knoxville, Iowa; F. H. Loud, St. Ignace, Mich.; S. W. Farnham, Minneapolis, Minn.; F. G. Mallette, Leon, Iowa; C. A. Cool, Waverly, Iowa; F. K. McIntosh, Brownville, Ind.; W. M. Johnson, Detroit, Mich.; J. C. Alderdyce, Detroit, Mich.; H. W. Barker, Detroit, Mich.; A. J. Rough, Virginia, Minn.; D. M. Forfar, Minneapolis, Minn.; E. J. Francis, East St. Louis, Ill.; W. C. Giffels, St. Johns, Mich.; M. R. Ethell, Bloomington, Ill.; B. M. Gallagher, St. Peter, Minn.; C. B. Holmes, Edwardsport, Ind.; C. F. Hinchman, Detroit, Mich.; F. G. Hoffman, Mount Carmel, Ill.; D. Heaton, Fowler, Ind.; E. P. Gray, Ann Arbor, Mich.; J. G. Oswalt, Danville, Ill.; H. Manderly, La Crosse, Wis.; F. W. Decker, Laporte, Ind.; B. C. Brennan, Kenosha, Wis.; E. F. Bridges, Oskaloosa, Iowa; F. W. Howard, Oscoda, Mich.; C. M. Goodrich, Detroit, Mich.; E. M. Graham, Rensselaer, Ind.; L. L. Linton, Saginaw, Mich.; M. A. Guerin, Detroit, Mich.; D. C. Fensternaker, Sioux City, Iowa; J. J. Murphy, Detroit, Mich.; H. Swenholt, Madison, Wis.; O. L. Meigs, St. Paul, Minn.; A. L. Schuffert, Wyandotte, Mich.; F. C. Young, Iowa City, Iowa; A. L. Trout, Detroit, Mich.; S. Thayer, Sioux City, Iowa; W. S. Richmond, Detroit, Mich.; C. T. Watson, Crosby, Minn.; P. F. Lyons, Freeport, Ill. First Lieutenant, Engineers—A. F. Victor, Ironton, Minn.; S. H. Michaels, Oak Park, Ill.; H. L. Peterson, Granite Falls, Minn.; F. T. Paul, Minneapolis, Minn.; W. S. Mussenden, Indiana Harbor, Ind.; L. H. Merrill, Hutchinson, Mich.; C. F. Merten, Garner, Iowa; W. H. Meyer, Milwaukee, Wis.; C. Prout, Springfield, Ill.; H. E. Schmidt, Hibbing, Minn.; J. Stone, Jr., Minneapolis, Minn.; R. F. Wheelock, Battle Creek, Mich.; B. T. Wherry, Jamestown, N. D.; J. F. Reynolds, Storm Lake, Iowa; W. C. Wyman, Ottumwa, Iowa; H. W. Sargent, Fort Dodge, Iowa; R. G. Flaugher, Cayuga, Ind. Second Lieutenant, Engineers—G. E. Gray, Des Moines, Iowa; R. T. Edwards, Ames, Iowa; O. F. Ernster, Brainerd, Minn.; W. H. Cumen, Shrewsbury, Wis.; W. C. Cooper, Des Moines, Iowa; W. T. Haight, North Vernon, Ind.; D. J. Donovan, Eveleth, Minn.; L. S. Gates, Dubuque, Iowa; J. B. Estabrook, Minneapolis, Minn.; W. G. Knickerbocker, Detroit, Mich.; R. A. Phelps, Madison, Wis.; P. D. Miesenhalder, Lafayette, Ind.; H. D. Mason, Iron River, Mich.; G. W. Stoddard, Milwaukee, Wis.; H. E. Smith, Berwyn, Ill.; P. W. Wilder, Calumet, Mich.; R. H. Van Cleve, Hibbing, Minn.

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[*] Bulletin 45 of the Engineering Experiment Station of the University of Illinois, by H. L. Whittemore, showed efficiencies of material in the joints of 75-85 per cent after the operator had become proficient.

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